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SPECIAL EDITION NO. 3

November, 1995

Volume 2



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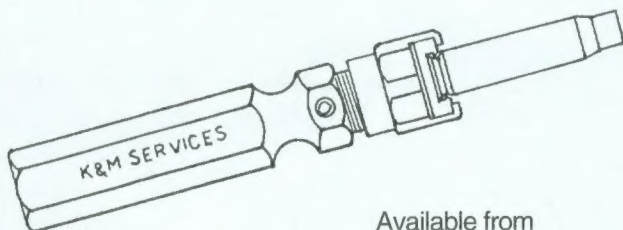


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NEW ZEALAND HIGHPOWER

(Kim Williams)

Dear Dave,

Just received the December 94 issue of PS and have seen that you are to continue the reports of the Palma Match, originally started by Don McKenzie and now continued by Dennis Flaharty on the Palma shoot here in New Zealand. Unlike Dennis, I did not shoot the Palma or the Individual World Championships but am one of those who, "make up the numbers", in the New Zealand National Rifle Association Championships shot immediately prior to those events.

Herewith, if you can use them, are comments on a couple of days in the NZ NRA meeting at Trentham. They started out as a half page, but "just grew".

I should first explain that the NZNRA rules allow 5.56mm, .303 British or 308 Win/7.62mm NATO to be used. If you shoot 7.62mm, then to be eligible for the Queens Prize you must use a military type projectile, ie: M80 Ball type, not to exceed 150.0 grains and iron sights ONLY. V bull dimensions are 3.2" at 300, 8" at 500/600, and 16" at 800/900/1000 yds.

A restricted class for 1995 allows the use of the 155gr Palma projectile and also a scope. It may be that the 155gr Palma could be adopted as our normal projectile but that awaits a review by the NZ NRA. It would be nice to shoot 190gr projectiles on a windy day at Trentham but that's the rules. Trentham has a reputation as a range with strong and variable winds that can drive you to drink or off it.

The Championship (referred to as the NZNRA), has several matches and team events, but revolves around the "Belt series", of two 10 shot matches at each range of 300, 500, 600, 800 and 900 yards. The top 50 shooters "the final 50", shoot the Queens Final of 15 shots at 900 yds. As well as the happiness in "making the 50", you get a nicely embroidered badge.

I started out in shooting in 1965 with my school team, continued with my University Rifle Team, and made the NZ Army Rifle Team in 1972. I was still in the Army Team when I left in 1990. One trip to Bisley in 1990 and several to Australia representing the NZ Army were my personal highlights in shooting. While I nurse ambitions to win the Queens Prize, several/many shooters turn out to be better. My rifle is a NZ made Barnard action, a 3 lug "Fat Bolt" design and like many NZ

rifles, has a wooden stock and an internal aluminum block, (no pillar bedding, just a solid aluminum block with a light skim of epoxy bedding under the action).

It has a 7.62mm NATO chambered 30 inch 1:13 twist Kreiger barrel with internal dimensions of .3065 x .298. My load is 45.5 gr of 4895 in a MEN case behind a 150 gr Lapua projectile, giving me 2930 fps at 15 ft. (CAUTION, this load was developed for this rifle only, with careful attention to pressure/extraction signs).

Evening Sunday 8 Jan. The Wellington Rifle Association meeting (10 counting shots at 300, 600, 800 and 900 yards) shot as a preliminary to the National meeting, is thankfully over. Strong gusty winds have made wind picking a matter of difficulty over each range and do not bode well for the next week of shooting. My rifle has held very good elevation but its owner has placed too many shots at 3 and 9 o'clock. Wind changes of 1 to 2 or more minutes between shots (quite normal at Trentham) have well and truly removed me from any prize lists.

The squadding list for the NRA Championship tomorrow is now completed and I find that I am a squad leader (you are assigned a squad and remain in that squad for the entire meeting), and am initially on target E8 and 3rd to shoot on Monday. On examination, I find that my 9 member squad includes a current Australian Commonwealth Games representative, a coach for the Great Britain Rifle team, a South African Team member, Dave Brantner from the USA and several other Australians and Kiwis.

While responsible for my squad members getting the right information and advice on how this shoot is run, that they know when to shoot and mark for the next shooter, my duties of squad leader essentially mean that I hump the scoring board back to the next range. Back to the clubhouse and an early night. My pre shoot nightmares of waking up in Trentham in a room full of snorers turn out to be awfully true and remain so for the next week.

Monday morning 9 Jan. Misty and wet with a light drizzle. While due to assemble at the first range, the word is passed for all shooters to meet at the NRA Headquarters. We receive a welcome address from the NRA President and in accordance with tradition, the names of those shooters who have passed away

during the last year are read out and we stand in silence. Shooting for today has been cancelled and a tighter programme will be shot during the week. Rejoicing for some who were not looking forward to shooting in the rain. The club bars open early and many people take the opportunity to socialize. I meet Dave Brantner and introduce myself as his squad leader and give him a big surprise by asking after his daughter Hanne. I ruin the surprise by telling him that I had been reading backnumbers of a shooting magazine that mentioned how well Hanne shot with her dad's rifle.

Tuesday 10 to Friday 13 Jan. Lots of shooting between 300 and 900 yards, wind conditions ranging from dead calm to the famed Trentham Fishtail (varying 1-2 minutes between shots and from left wind to right wind and back on a random basis). Some people handled the conditions very well and others crashed and burned.

While 20 or more wind flags were placed on the range, many USA shooters were more accustomed to the use of mirage and their wind picking suffered.

In the general socializing after each days shoot (the clubhouses are clustered behind the 1000 yd mound), one American (Name suppressed) revealed that his scores during the week were very bad, not only from the wind but the groups were very big, not to say enormous. He was unhappy as he had used the issue 144gr ammunition, wanting to

Continued on next page

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NEW ZEALAND HIGHPOWER

Continued

try for the Queens Prize, and his rifle seemed to have totally lost accuracy. The comparison of rifles came up and he noted that his barrel was .3079 and I had to tell him that the issue 144gr bullet was averaging .3075. I need not dwell on the expected accuracy. (Dave, you have previously noted in PS that Commonwealth shooters have much tighter barrels than US shooters, due to us having to use .3075 bullets).

My rifle has continued to group well and definitely likes being cleaned after every shoot, no copper fouling, just powder fouling needing to be removed. No ammonia, just powder solvent on several patches until clean and then 5 strokes with a bronze brush after 20 rnds followed by more patches. It seems to work. I pick up the high score for the short range aggregate (300/500/600) on the first days shoot.

The final results are out, and I have ended up 26th (out of 475) and will shoot the next day in the Queens Final, 15 counting shots at 900 yds for the top 50 shooters. I am very pleased, having

made the 50 in Palma this year and having also been in the 50 in 1979 when the Palma was last held in NZ but not too often in between. Tonight I keep my earplugs in and the snorers do not wake me (or I am now used to it!)

Saturday 14 Jan. 1:45 pm. A hot cloudless day and bundled up in my jacket the sweat is rolling off me while lying on the mound. The team shoot in the morning showed that my rifle continues to group tightly (Thank you Mr. Kreiger), the barrel is clean and my 17 rounds lying ready. The obligatory 2 minute sighting period is over and when the targets next appear, I can commence



Final 50, Trentham Range NZ. 900 yards Queens Final Score 73.8V. Morrie Win left, Kim Williams on right.

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AMT Custom Shop	17	JGS Precision Tool Mfg.	88	Premier Reticle	23
Answer Products	45	JP Enterprises	83	Pro-Shot Products	62
Bald Eagle Precision Mach.	19, 91	K & M Services	2	Robinett, Randy	56
Bay-Com	77	Kaltron-Pettibone	99	Schneider Rifle Barrels	95
Beinke & Beinke	87	LaBounty Precision	91	Shilen Rifles	97
Berger Bullets	57	Lehman Optical	47	Sierra Bullets	39
Bull Mountain Rifle Co.	78	Lightforce	27	Sinclair International	9
Clymer Reamers	43	Marquart Precision Co.	95	Six Enterprises	35
Cryogenic Tempering/-300	25	Mitchell Optics	8	Speedwatch Instruments	21
Dalley, Bill	94	NECO	93	Spencer's Custom Guns	2
Dorn's Gun Service	95	OK Weber	87	Technical Video	37
Gentner Bullets	78	Optic	7	Timney Triggers	63
Hammonds Rifles	54	Optical Services	3	Wentling, S.A. & Co.	49
Harris ° McMillan Gunworks	46	Parsons Optical Mfg.	93	Wessinger Custom Guns & Eng.	94
Hidalgo, Tony	85	Precision Reloading	29	Westwind Rifles	55
Jarrett Rifles	81	Precision Shooting Publications	2	Williams Precision	100
JBM Software	79	Precision Shooting Subscription	98		

firing. For the moment, the wind is blowing steadily from the right and I have selected 6 minutes of right wind for my first shot. Having watched the wind flags during the last 30 minutes, while these conditions last, I shall shoot as fast as possible and alter on the spotter. This is normally a quick way to a low score at Trentham but the wind is steady with no indication of variation, as yet. My game plan is to get all my shots away before the wind becomes variable. I pray for a fast marker.

My two scorers are ready, one on a large plotting sheet allowing spectators to see where each shot goes (not always a comfort to the shooter) and the other on the score card. My target appears and I fire.

Sighting is difficult with a bright target but a low 4 is marked for the first sighter. Up 1 min elevation and add 2 min right and fire. I have a fast marker and my game plan looks good, second sighter a high bull, fire again, a high 4, wind is increasing, add 1 minute and down half and fire. V, another V, V, 5 drifting out to the right... take off 1 minute... fire, V. I complete the 15 shots, getting another 4 and a total of 73.8V. I am the first of the 50 to finish and pleased with my score which advances me 5 places in the 50.

My scorers were Morrie Win (also my scorer for the same shoot in 1979, great and patient help to a young beginner in 1965, aged 73 and still showing us how to shoot), and Ed Ilston (another PS subscriber) who congratulates me and takes my photo next to the plotting sheet. In the centre fire of the 50 targets attention is concentrated on the two high scoring Kiwis shooting it out for the Queens Prize, Ross Geange wins by one point from my fellow clubmate Shane Reagan. Ross is placed in the Champions chair, hoisted on his friends shoulders and the band pipes him off the range. NZNRA is over for another year, I have finished 21st overall for the championship. My aim now is to concentrate on better wind picking, looking after my barrel very carefully and see what I can glean from the pages of PS that can lift my scores.

I enclose a photo taken immediately after the Queens 50. Morrie Win on the left, and self on right. View from the 900 yard mound.

Kim Williams
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PRECISION SHOOTING TABLE OF CONTENTS

SPECIAL #3, VOLUME 2, NOVEMBER, 1995

NEW ZEALAND HIGHPOWER (Kim Williams)	3
A BALLISTIC EXPERT TAKES AIM AT HUMMER BARRELS - Dave Scott ..	6
Palma . . . THE ODYSSEY OF THE FOURTEEN - Tom Lintner	10
Palma . . . A SHOOTER'S WIFE'S TRIP TO THE 1992 PALMA MATCHES - Elizabeth Wessel	15
THE SAVAGE M112 BVSS-S - Bob Jourdan	20
MYTHS ON AGED AMMUNITION REVIEWED - Norman E. Johnson	24
CLEANING RIMFIRE BARRELS - Milt Cook	30
BULLET YAW - Merrill Martin	34
"CARBON ONE" - C.W. "Chuck" Cornett	38
TROUBLE IN (HIGHPOWER) PARADISE (Bernie Friessecke)	42
HARRY M. POPE'S HARTFORD, CONNECTICUT HOME AND SHOP FOUND, IN EXCELLENT REPAIR - Dave Brennan	48
SLICK BULLETS - Terry Wright	52
FORMING THE LOCKING LUG RUNWAYS IN HOMEMADE RECEIVERS - Dr. K.W. Erickson	55
EXTERIOR BALLISTICS AND WIND DRIFT OF CALIBER .22 LONG RIFLE MATCH AMMUNITION - Robert L. McCoy	58
THE QUIET RIMFIRE, AND MORE THOUGHTS ON AN ACCURATE 10/22 - Mark White	64
SHOOTING FLIES AND BUG HOLES - Bill Bartram	68
ESTIMATING VELOCITIES REVISITED - Don Miller	71
ALL YOU WANTED TO KNOW ABOUT EYESIGHT - Harold J. Pantely	76
LET'S GET REAL ABOUT ACCURACY - John M. Kolyer	80
THE MODEL 75 ONCE AGAIN - William Law Hartman	84
HOW TO MEASURE GROUPS - Dan Hackett	86
BALLISTIC MISSILE DESIGN - Theron King	89
HOME-MADE "PRESS CASE EJECTOR" (Walter Engel)	92
MORE ON HEAT TREATING CAST BULLETS - Glenn R. Latham	94
THE MIDWAY REVOLVING RELOADING STAND - Bob Jourdan	97

A BALLISTIC EXPERT TAKES AIM AT HUMMER BARRELS

by
Dave Scott

For years, the persisting hummer barrel legend has fueled our imaginations and captured our cynical hearts. In a sport ruled by the cold, rigid laws of physics, hummers represent the last vestige of shooter longing. After all, what shooter hasn't dreamed of the rifle that ignores the wind? Who among us doesn't fantasize of the bullet that makes a mockery of computer-generated trajectories? Could there exist an overlooked aberration that exempts a bullet from the cruel constraints of exterior ballistics?

That possibility was convincingly raised in 1987 by benchrest great Tony Boyer of Keezletown, Virginia. Writing in *Precision Shooting*, Tony for the first time brought to the readership's attention the mysterious phenomenon that had been quietly circulating in competitive benchrest circles for years. After shooting a friend's extraordinary benchrest rifle, Tony described his initial encounter with a hummer barrel this way: "The barrel shot well in calm conditions; it was when conditions began moving around out in front of you that the way the barrel would shoot became sort of...well, eerie. Even if you were not picking up the conditions or the switches all that well, the barrel would keep putting them through the same hole..."

He added that accuracy gunsmith and fellow benchrest competitor Myles Hollister theorized that the bullet from a hummer stabilized faster upon exiting the barrel, and thus the wind did not have as much effect on the bullet. Mr. Hollister, from Whitehall, New York, further asserted that shooters who had been around for any period of time knew hummer barrels as fact.

For an article in the November, 1994, *PS* Special Edition No. 2, I interviewed both Tony and barrelmaker Ed Shilen in an attempt to shed more light on the controversy. Tony is probably the leading advocate of the hummer barrel concept, and Shilen Rifles makes Tony's barrels. Given that relationship, it would seem likely that both gentlemen would see eye-to-eye on the phenomenon. Not so. The two offered contrasting degrees of optimism over the chances of a remarkable barrel capable of launching

wind-resistant bullets. The Texas barrelmaker's skepticism becomes even more meaningful when one considers that in several years past, Ed Shilen dominated benchrest competition, an accomplishment that earned him membership in the vaunted Benchrest Hall of Fame.

Even so, any mortal has to break out in a cold sweat debating the subject of rifle performance with Tony Boyer. Considering his absolute dominance of benchrest over much of the last dozen years, as well as his extensive investigations into hummers, no one is more qualified to identify a barrel that disputes the orderly dictates of wind deflection than Mr. Boyer, who of course also occupies a lofty perch in the Hall of Fame. His experimentation into the hummer mystery, spanning nearly a decade, clearly makes him the foremost authority on the subject. His conclusions, based not on theory but on what he and his friends have experienced out there in the real world of shooting, are perhaps as convincing as the immutable laws governing a bullet's flight.

For a glimpse into Tony's understanding of how any condition acts on his bullets, consider his words from the 1994 interview: "When I'm testing a barrel, I'll touch off a shot, and by sensing the wind on my body and watching the wind flags, I know that the bullet should have moved over, say, one bullet hole at 100 yards. If it moves only half a bullet hole, I know I've got something."

Obviously, a shooter does not gauge such tiny increments of wind deflection from casual shooting. Mr. Boyer's intimate familiarity with breezes arises from tens of thousands of rounds fired from extremely accurate rifles. As important, each shot must be released with fierce concentration and then carefully analyzed in light of what the wind flags reveal. All this data is stored in the computers of Tony Boyer's mind for instant downloading just before the firing pin falls.

Although Tony is quite capable of identifying unusual barrel characteristics simply by calling upon his wealth of experience, there's another technique perhaps more convincing in isolating hummers.

On windy days he and wife Faye (who also is banging on the doors of the Benchrest Hall of Fame) invite shooting friends to the Boyers' own range to engage in an experiment called "chase". All shooters must have extremely accurate rifles—rifles that in fact group to similar dimensions in **calm air**. Targets are tightly clustered at 200 yards. Disregarding the breezes and taking dead aim at their assigned targets (as opposed to holding off), the participants release their shots in a predetermined order and in an interval of just a few seconds.

Even though the bullets are encountering virtually identical conditions, Tony has observed there are usually glaring differences in the way the bullets buck the wind. With a trend developing, the shooters retreat to the loading area to adjust loads for the prevailing conditions. After the smoke clears, Tony has observed that a true hummer barrel absolutely cannot be beat, either in wind deflection or in group size, by the other contenders, regardless of load tuning.

Such direct comparisons in the real world of shooting constitute compelling testimony in support of hummers. But does empirical evidence alone hold up under the scrutiny of classical exterior ballistics? To get the scientific side of the issue, I recently contacted exterior ballistics consultant Bob McCoy of Stewartstown, Pennsylvania. Mr. McCoy entered the consulting field following his recent retirement after 32 years with the U.S. Army Ballistic Research Laboratory at the Aberdeen Proving Ground in Maryland. Educated in Aerospace Engineering, Bob was involved in theoretical and experimental exterior ballistics at Aberdeen. The experimental portion of his work consisted of wind-tunnel projectile testing, as well as spark photography of projectiles in flight. His theoretical studies included six-degrees-of-freedom trajectory calculations involving every factor that acts on a bullet in flight. To say Bob McCoy is qualified to speak to this particular issue would amount to gross understatement.

In prefacing his comments on the validity of hummers, Bob confessed he had never tested a benchrest rifle, much

less a hummer barrel. Nevertheless, he concludes that a hummer—provided there *is* such a thing—can only be explained in terms of bullet drag. “The first thing that comes to mind,” he said, “is that a hummer barrel is probably a barrel that launches all its bullets with extremely small yaw. Nearly all bullets fired from ordinary ‘good’ barrels show significant epicyclic pitching and yawing motion in the early part of the trajectory. This epicyclic motion is caused by many factors; one of the most important is dynamic unbalance of the bullet.”

So far, so good. Bob tends to confirm the prevailing theory expressed by Myles Hollister that—to put it in scientifically correct terms—the epicyclic motions and yaw of bullets from a hummer barrel perhaps damp faster as they exit the muzzle.

But why does the just-launched bullet begin these troublesome movements in the first place? Of the several reasons, dynamic unbalance of flawed bullets is, as Bob stated previously, the most common. Others include tilt (crookedness) and other deformation of the bullet while it's in the barrel, as well as the effects of muzzle blast. Regardless of the cause, it's essential to recognize that the only explanation for the hummer phenomenon is variations in air drag. And to take it a step farther, if two rifles with the same twist are shooting identically configured bullets without interior flaws at similar velocities, drag variations can only occur as a result of unequal yaw and epicyclic pitching.

From Bob McCoy's perspective, the existence of a barrel capable of launching bullets with a built-in wind advantage, while certainly possible, must presently remain scientific conjecture. How can it be proved? “The only way to absolutely determine if there are any ‘special’ exterior ballistic characteristics of bullets fired from a hummer barrel would be to do a comparative test of a hummer versus an ordinary ‘good’ barrel in a modern facility such as the Ballistic Research Laboratory Aerodynamics Range,” he stated. “Unfortunately, such testing is not inexpensive. At the time I retired, the going rate was \$2,000 per shot, and at least a dozen test shots (a half-dozen from each barrel) would be required to answer the question with any statistical validity.”

In this indoor range, 40 stations distributed over 100 yards measure a bullet's position in space to plus or minus .01". In addition, the angles of pitch (vertical tilt) and yaw (horizontal tilt) are measured to an accuracy of plus or minus .1 degree, and the time of flight is measured to an accuracy of plus or minus .5 mil-

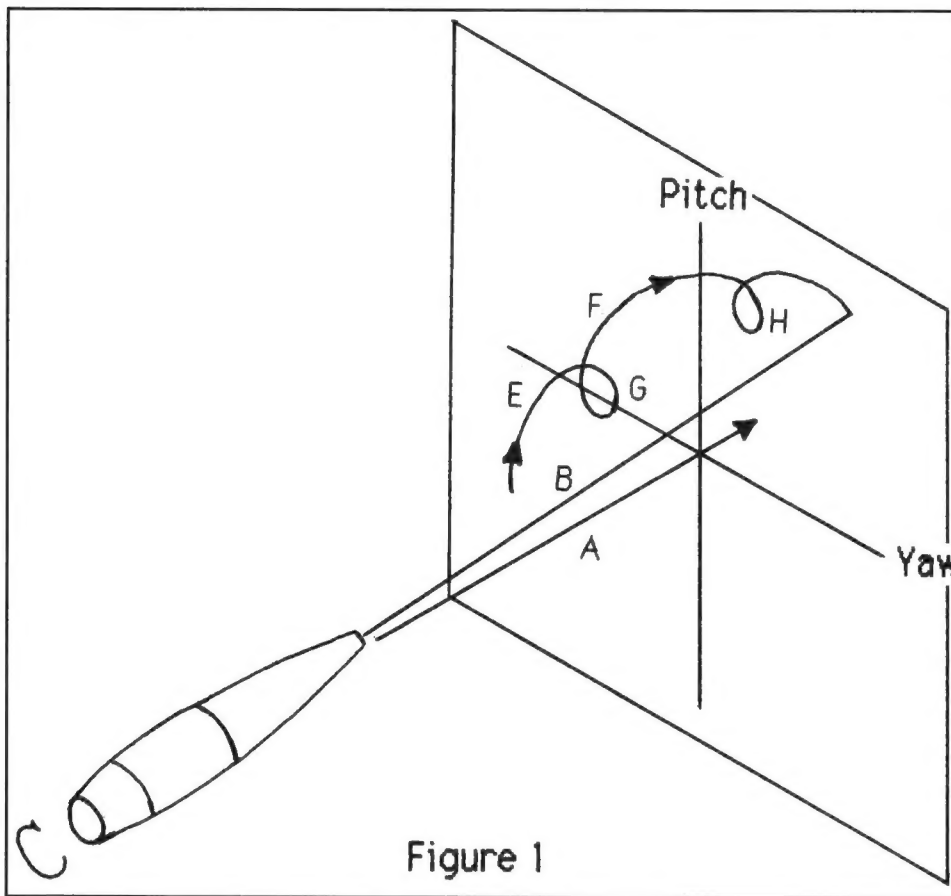


Figure 1

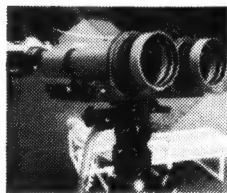
lionths of a second. Bob pointed out that the incredibly precise photographic measurements of bullets in flight also isolate the small helical swerving motion produced by pitch and yaw to a level of accuracy that Dr. Franklin W. Mann, author of *The Bullet's Flight*, could only have dreamed of.

Now, my shooting friends, let's take a deep breath, sip our Big Reds and calm our nerves while all this sinks in. Unless you're light years ahead of the rest of us, terms such as yaw, pitch and epicyclic tend to make one's eyes glaze over. So let's take a look at puzzling Figure 1. It's important that we grasp the contortions

our bullets go through as they fly down-range. Although this is pretty technical stuff, it's not rocket science. It may be more complicated than rocket science. Even so, we can visualize the movements, at least at a layman's level.

Line A extending out from the bullet point is the bullet flight path, or trajectory. If a perfectly balanced bullet departed the muzzle perfectly straight and without any of the motions already described, its nose would point precisely along line A as it flew. Unfortunately, nothing is perfect, including the flight of our bullets, so in the real world the bullet exhibits

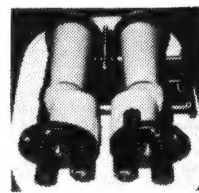
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pitching and yawing of varying degrees illustrated by line B extending out from the bullet point. Before we get to epicyclic motion, understand that the line entitled Pitch merely depicts the vertical scale, both up and down. The line entitled Yaw is horizontal, both left and right. By strict ballistic definition, pitch is vertical movement, and yaw is horizontal movement. As a confusing convenience, however, ballisticians—including Bob McCoy—commonly invoke the term “yaw” to describe pitch, yaw and even epicyclic motion.

When a bullet leaves the muzzle and before it—in shooter’s parlance—“goes to sleep”, it exhibits pitching and yawing motion (E and F). In other words, the bullet base and nose are making circular movements in addition to spinning. But the gyrations of bullets are still more complex. A second motion (G and H) is occurring at the same time. This means the bullet point is inscribing one cyclic movement at the same time it’s inscribing another, thus the term epicyclic. If the bullet is gyroscopically and dynamically stable, the epicyclic motion will damp (the bullet goes to sleep) in its flight. However, if the twist is too slow, or should the bullet exhibit gyroscopic or dynamic instability arising from its design, fabrication or in-bore damage, rather than damping, the motion will actually grow as the bullet travels down-range, causing keyholing.

With that introduction, now let’s go to

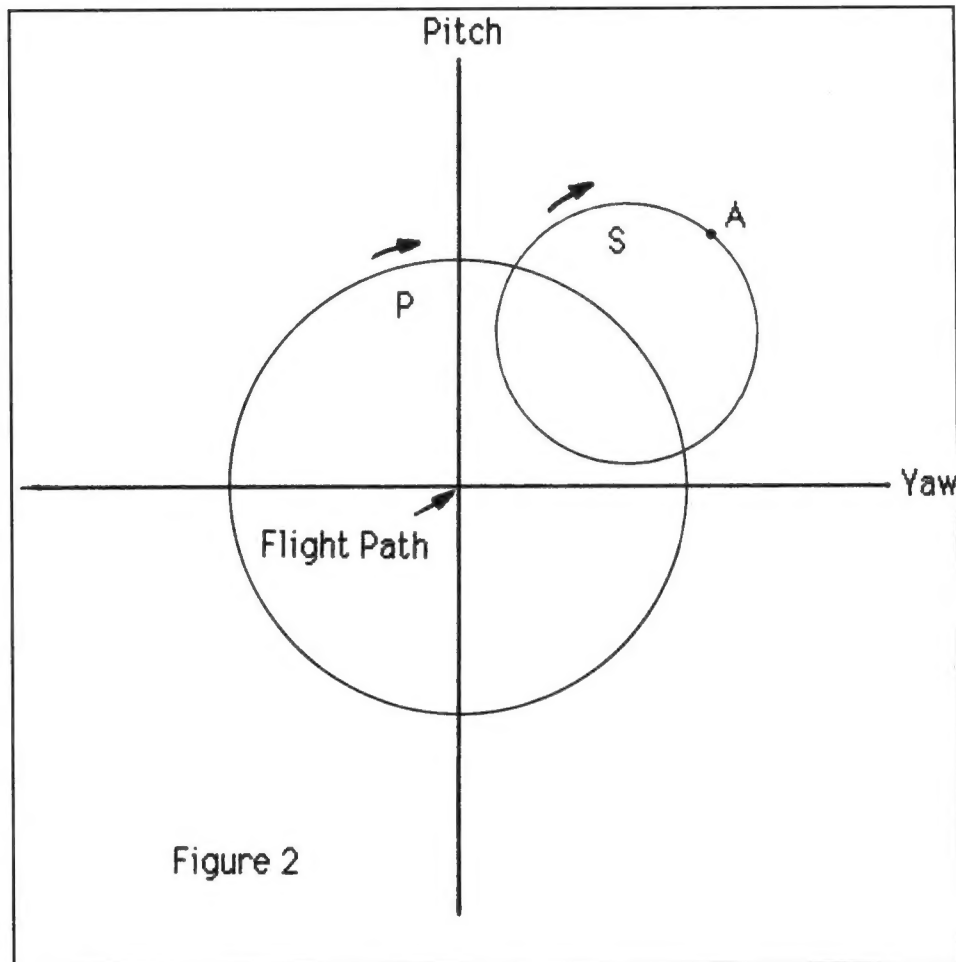


Figure 2

Figure 2 for another perspective on the same bullet behavior. Once again, the center is the flight path. If the bullet point made only a single, circular yawing and pitching movement around the flight path, it would inscribe a pattern such as the circumference of circle P. This motion is known as the Slow Mode. However, as already explained, another motion—this one called the Fast Mode—

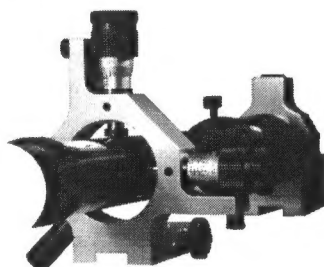
will occur at the same time, as depicted by circle S, with its center point on the circumference of circle P. Now visualize the Fast Mode motion of circle S occurring repeatedly around the circumference of circle P as the system is set into motion. Point A will then trace the complex pattern of the bullet nose in undamped epicyclic motion, a pattern much like that shown in Figure 1.

Both drawings indicate that the Fast Mode amplitude is smaller than that of the Slow Mode, but it can be the other way around. Regardless of their sizes, the outer Fast Mode always rotates with greater angular velocity than the inner Slow Mode.

Although Bob has not tested 6mm benchrest rifles in the spark photography range, he has measured epicyclic pitching and yawing motions in bullets fired from a Remington 40-X rifle with 12" twist in .308 Winchester. From the photographic measurements he has found that 168-grain Sierra Match King bullets fired from a ‘good’ barrel (assumed not to be a hummer) routinely produce maximum epicyclic pitch and yaw angles of 1 to 3 degrees, with an average of 1 to 2 degrees over the first 100 yards of flight. “This level of epicyclic motion causes a

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drag increase of .5% to 2.0%, with an average value of approximately 1.2%," Bob explained. "This very small drag increase *would not cause a detectable increase in wind sensitivity.*"

So exactly how much advantage could a hummer barrel that launches its bullets with **no** epicyclic motion provide over a 'good' barrel that sends its bullets sailing with an average of 1.2% additional drag from this factor? In the case of the .308 Winchester just cited, the same breeze that deflects a bullet from a 'good' barrel .52" at 200 yards would shove a bullet from a hummer .50"—a .02" advantage. As we can see, this is an insignificant difference in wind deflection. The hummer advantage is further diminished when we realistically acknowledge that bullets from *any* barrel are not likely to depart in perfect flight.

Based on this trifling difference in wind performance, is it possible that the same breeze that nudges a bullet from a 'good' barrel aside 1" at 200 yards would affect a hummer only half that much? According to Bob, it is possible, but just barely. For this to occur with the .308, bullets from the 'good' barrel would have to wobble downrange at an average pitch and yaw level of 14 degrees to create the required, whopping 88% increase in

drag. "Even the worst junk military rifles don't produce that much pitching and yawing motion," Bob declared, "and you can't hit your hat with them at 200 yards."

Okay, so the hummer advantage would amount to practically nothing with 168-grain Sierra bullets fired from the 40-X. But are the possibilities greater with 68-grain, 6mm benchrest bullets, given their poorer ballistic coefficients? As a ballistic scientist, Bob McCoy takes a dim view of guessing and speculation. He declined to attempt extrapolating aerodynamic data for the .308" Sierra bullet to the classical 6mm match weight and design. He said it would be feasible, however, to have comparator measurements made and then use computer programs to closely estimate the ballistic coefficient and gyroscopic stability of a specific 6mm bullet. Unfortunately, even with this data there's no way to determine the rate of pitch and yaw damping and the resultant drag factors. These are what we must know if we're to get anywhere with the hummer riddle, and these can be measured only with spark photography.

Before we wander off to form our own conclusions, there is one last consideration. The 168-grain Sierra bullet spun by

a 12" twist provides a safe rotational margin, and because of this its cyclic motions would be inclined to damp quickly. By contrast, benchrest twists spin bullets at the ragged edge of gyroscopic stability. Therefore, if bullets from a 'good' 6mm benchrest barrel are slower to damp than the .308 we're using for comparison purposes, wouldn't a 6mm hummer that somehow accelerates the damping process have an exaggerated advantage in wind drag over the 'good' 6mm barrel? And if so, wouldn't the contrast in wind deflection be greater?

Granted, the controversy presently appears to be going nowhere. Even so, we can be encouraged that the rift between science and shooter is not over the basic hummer concept. Both sides agree that the phenomenon is both plausible and explainable. Instead, the dispute is over measurements. *How much* advantage can be realized? Until Editor Brennan coughs up \$25,000 from petty cash for spark photography (don't hold your breath), perhaps the best thing we can do is try to obtain the best estimates from talented, experienced shooters such as Tony Boyer. At the same time, it would indeed be wise to heed the words of caution from Bob McCoy and not expect too much.



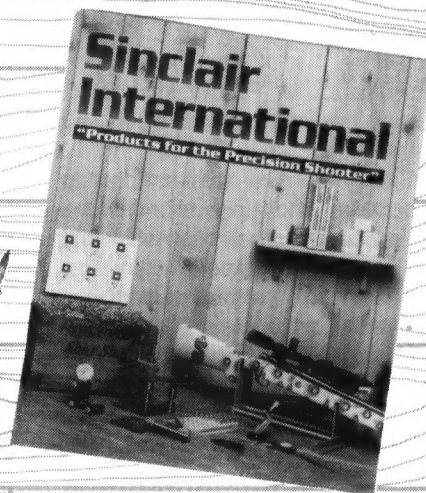
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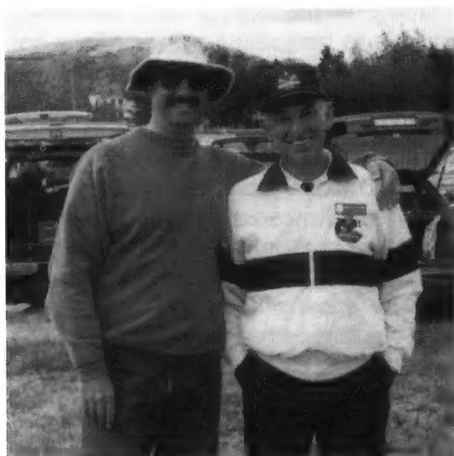
Palma

The Odyssey of The Fourteen

(Palma, 1995)

by

Tom Lintner



The author with Bert Rollins, top shooter on US Team, two Virginians who "done good" (one much better than the other).

Well, by the time this gets published (through nobody's fault except my own ability to procrastinate), everyone will have already heard about the results of the 1995 World Palma Match in New Zealand where the US took the Silver. Yes, this is another Palma story but, please, keep reading, I promise this will be different!!

Recently, there have been articles in several popular shooting publications that have covered the championship that was shot in New Zealand in January. However, none of them spoke about what's it like to participate in that type of event. Since it sure ain't like a day at Quantico, I thought I'd offer a different perspective.

Now I know you've all read about the members of the US Palma Team but did you know about the "other" US shooters who were also representing the United States? There were 14 of us, Noel Sugden and Peter Church from Michigan, Dick Wyatt from North Carolina, Mark and Carol Sproul from New Jersey, Earl Liebetrau from Wisconsin, Dave Brantner, Forrest Browning, and Stephen McQuain from West Virginia, Bob Gamboa (the builder

of the famous "Gamboa Palma Rifles" which many of us carried), Ray DelRio and Roger Culbertsen from California, George Hutton from Hawaii, and myself. We all went to New Zealand, with no coaches, no gunsmiths, and in some cases, no clue what to expect, and did the best we could. This, to a great degree is our story. But before I tell the personal side, let me give you all a flavor of international events beyond the normal scores and rankings...

First, let me say that international shooting (especially in foreign countries) is like nothing I've ever encountered in the U.S. Kinda makes sense when you think about it but, you'll see what I mean. One of the major differences, and the most often asked question, deals with travel and transport of firearms into other countries. This was the 3rd time I traveled for an international match and the greatest challenge is dealing with the weight requirement (75 lbs) that is imposed by the airlines. With a little practice this will work (it's amazing what you don't need) and I've never had a problem with the rifles. In and out of Canada they never even looked at them.



Mark Sproul from New Jersey. Both he and his wife Carol are avid Palma shooters.

Into/out of New Zealand you needed a permit that was picked up at the airport and took 10 minutes (they even waived the \$25.00 fee because of the "major nature" of the event). To carry the firearms all you need is one of those heavy duty aluminum cases that can be locked (preferably, with an external



Bob Gamboa scoring at 800 yards.

Master type lock). Regarding carrying ammo, the airlines have a limit of 11 lbs per shooter and this can be carried in checked baggage, just make sure it's in factory boxes (and for God's sake, don't pack it with the rifle!!). For some reason airlines want no part of handloads but factory ammo, hence the boxes, is OK (No, I don't have any idea what the difference is supposed to be). However, keep in mind that in most foreign competitions, you generally shoot issue ammo and therefore transporting rounds of ammo becomes a moot point. Only this year has Canada changed their rules to allow competitors to use their own ammo. Suffice it to say that if you even have the slightest thought to participating in this type of adventure, don't let these issues stand in your way. Now, the 18 hours on an airplane might be a factor but don't worry about these details.

WHAT TO EXPECT

For those of you who may not be familiar with the format of these matches, let's do a basic overview. The biggest difference between our "matches" and their "meetings" (outside of the US, "matches" are called "meetings", a little more civilized, what?) is that everything is shot prone slow fire. There's no such thing as standing or rapid fire and the shortest range is 300 yards (no, not meters, and please don't ask).

In the case of the New Zealand competition we participated in, the event covered 17 days and began with the NRA of New Zealand National Championships. This was similar to our National Matches at Camp Perry and also has a counterpart in all of the participating countries around the world. The first day was the Wellington Rifle Association Championship. In NZ, as well as most countries, there are numerous local clubs that compete. They all have their own club houses which are generally located right on the range (well, no, not ON the range, behind the last firing line!). At Trentham, NZ and at the Bisley Camp outside of London, these club houses have formal dining rooms, bars, sitting areas, reading rooms and trophy rooms. I was a recent guest at the North London Rifle Club at Bisley and stayed in one of the 16 rooms at the club. Believe me, these are not the huts at Perry and you get served breakfast off of china plates (honest).

Sorry, I went off on a tangent. Anyway, the first match was a competition between clubs but anyone could participate. We shot a total of 10 rounds at 300/600/800/900 yards which could be made up of 2 "convertible" sighters.



Yes, Virginia, there is a Santa Claus, and a tea truck in New Zealand.



Dave Brantner getting ready to attempt to duplicate his 1000 yard Gold Medal performance.

"Convertible" means you shoot the first 2 sighting shots and then you can decide if you want to keep them for score or throw them away. (No, it's not stupid and we'll talk about that later.) Just for the record, I've simplified this somewhat but I think you got the idea.

The next day began the Masfield Stage and the Belt Series. The Masfield was named after a famous New Zealand shooter from "way back when" and that folks, is another significant part about the mystique of international shooting. They've been at it a lot longer than we have and, perhaps more importantly, they remember it. In one of the clubs at Bisley there is a plaque listing the winner of the Queen's Meeting (this is similar to our "President's 100" but, from what I've seen, even more difficult) that goes all the

way back to the mid 1800's!!!! We were in the middle of the Civil War and these people were shooting competitive long range matches! You stand there and look up at that list and shake your head in wonder (then think about why we don't recognize our people the same way).

The Belt series was named for a physical "Belt" that the winner wears at the end of the match with the names of all the previous winners. This thing is huge and impressive and fought for by every shooter. Both of these events cover 6 days at ranges from 300 to 1,000 yards shooting from 7 to 10 shots. Total shots fired was 195 rounds.

From there we went to the Australia Match which is a match shot at 300/600/900/1000 yards, that can only

Continued on next page

The Odyssey of The Fourteen

Continued

take place when Australians are there. Again, please don't ask, it made sense at the time but I'll be damned if I can explain it now. Unfortunately, at this point Ray DelRio and Roger Culbertsen had made prior plans to return home and left the rest of us to face the second week alone. They had shot exceptionally well and could be proud of their performance.

The following week began the Individual Long Range Rifle World Championship which was, in fact, 3 days shooting the Palma course (15 shots at 800/900/1000 yards). The event then culminated with the Palma Team match where the US came in second after learning they needed more experience coaching the tricky wind in New Zealand.

Now, if any of this has started sounding confusing, trust me, it's not and there are other things which add to the enjoyment of these events. In the area of creature comforts, shooting started around 8:30 after breakfast. At around 10:00, a truck came out and the line officer announced "tea time" (honest). Everyone went to the truck for a "spot of tea," cake, cookies, or if you were really hungry, a tomato sandwich.

Shooting continued until around 11:30 when we all stopped for lunch and headed back to the clubs. Hot meals, sandwiches (my favorite was the spaghetti sandwich on toast) and free drinks were available. After about an hour (or so) we all went back to finish the last firing line before calling it a day around 3:30. So, just for laughs, compare this to a 4am wakeup at Perry; "breakfast" in the mess hall, a quick trip to the "john" (due to the mess hall), muster on the line by 5:30am to get ammo, spend all day to shoot 30 rounds, and then do it all over again the next day, and you might understand why I'm hooked on international events.

Sorry, I went off on a tangent again....more about how the matches are conducted.

When you are squaded, you are grouped with several people (5-8) and assigned a target. You will stay with these people for the duration of the match, which may mean several days. A metal "black board" is at each point and on it you list the members of the squad. The individual scores will be recorded as the day progresses. This way, someone can walk the line and see, on a shot by shot and total basis, how each person is doing. You don't have to wait until the

end of the day at the "wailing wall" and you now have a spectator sport.

Starting to make sense? Well, hold onto your hats for this, it took me 2 days to learn it (sort of) but it's a great idea. After everyone had finished shooting at, say the 300 yard line, the squad moved back to the next line (say, 600 yards) and moved 7 targets to the right! For example, if we started on target 10 at 300 yards, we shot on target 17 at 600 yards, target 24 at 800 yards and 31 at 900 yards.

Our rotation in the squad also changed as we moved back. So, the first shooter at 300 yards was the last shooter at 600 yards, etc. Yes, I know, at first I said "what the...." but, think about it, we never got caught with a bad pit puller all day (by the way, in international events you don't pull targets). We didn't have to worry of being "trapped" on one side of the range or in one relay and we got a "flavor" of the entire range during the day. Anyway, in spite of how it sounds it did work well (but imagine trying this at home).

OK, so much for the basic overview, I know you're all saying, "yea, but how did you guys do?" Just wait a little, let's talk about equipment first (this way I'm setting up additional excuses).

EQUIPMENT AND STUFF

There can be a significant difference in several aspects of international shooting, some of which I've highlighted above. Other factors center around ammo, the rifles, and what I called "the great debate." As I mentioned, in New Zealand, as in most international competition, you are issued ammo and must shoot it "as is." This factor, to a great degree, is what caused so much interest in the "multi-lug" rifle actions. Now, this is going to sound like "evolution according to Darwin" but please bear with me...

When I talk about the "multi-lug" action, I'm referring to those bolts with more than 2 lugs (sometimes called Swing actions). Although there are several action types available, probably the most commonly seen today are the Paramount and Stolle. Since I'm most familiar with the Paramount, I'll refer to this for examples.

The heavy, 4 lug Paramount action provides the international shooter with a couple of advantages; first, the uniform pressure on the case head and, (2) the fast lock time associated with an excep-

tionally heavy firing pin spring (40-50lbs "ish"). Attached to the action is a kinda special barrel. On my rifle, which was made by Bob Gamboa from Sacramento, CA, is a 30" 1-13 twist Krieger 4 groove barrel with a "Palma Contour" which is a lightweight and tapered contour. Those of you accustomed to shooting the "normal" heavy barrel across-the-course rifles would look at this and say, "you've got to be kidding!" But remember, in international shooting the rifle has a maximum weight limit of 6 kg (13 lbs 3.7 oz and a minimum trigger weight of 1.5 kg or 3 lbs 4.8 oz). These barrels, which have dimensions of .3065x.298 and are known as "tight" barrels, allow us to make the weight limit. Again, the rifle Bob Gamboa made for me has a core diameter of 1.0935, is set for zero headspace and had a chamber cut with a custom made Henriksen reamer specifically designed for the Sierra 155 grain Palma bullet. By now you're probably saying, "OK, so what?" Well, to answer that we have to go back to the ammo...

In the US, we're all used to shooting "heavy" bullets, i.e., the 168 grain for across the course, the 190's at 600 yards and, for the real lunatics, 220 grains at 1,000 yards in the magnums (which by the way, you'll never see me shoot again). Again, remember that in international events you shoot the ammo that is provided by the host country. Generally, the ammo is pretty good (or in the case of the ammo made for the 1992 Palma by Bob Jensen, outstanding) but you have to be ready for anything.

In New Zealand, during the NZ National Championship, the issue ammo was a 147gr FMJ which was crimped into a 7.62mm case. For the Individual and Palma Team Match, we used the 155gr Sierra Palma bullet on top of 44.7grs of AR2208 powder, an ADI 7.62x51mm case and a Winchester No.34 primer. ADI brass is from the Australian Defense Industry and the AR2208 powder was Australian Army powder. What we later discovered was that this same powder is what Hodgdon is marketing as "VAR-GET" and I know why Hodgdon is sold out of it. Except for it being exceptionally "dirty" compared to IMR4895, it performed very well in the .308 cases with the lightweight bullet.

Even though the 1st week's ammo went against every rule in the book (FMJ in a crimped case!) I found it shot well and averaged about 1/2 to 3/4 MOA. I attributed this to the Paramount action and the outstanding work done by Bob Gamboa (along with a couple of good wind guesses on my part). Due to the

weather conditions (and a fair amount of stupidity on my part) it was difficult to assess the quality of the ammo during the second week. All of this then took us to what I called.....

"THE GREAT DEBATE"

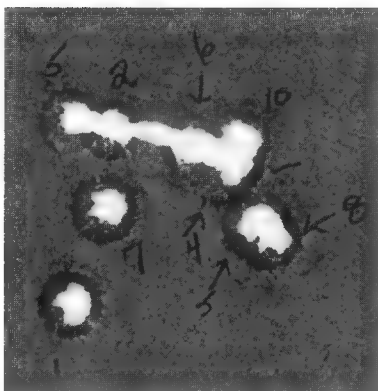
When we got to New Zealand, only 3 of us (the independent shooters) had rifles which were built on Paramount actions. The rest of the group were primarily shooting Winchester M70's with 1-12 twist barrels. There may have been some additional combinations but I honestly don't remember. Anyway, the debate soon began over what's the advantage of the Paramount over the Winchester and why should anyone pay \$850.00 just for an action.

After a lot of long discussions, the general feeling was that, if you have the ability to custom load for a specific rifle and "fine tune" the ammo to the gun, the Winchester should fairly well keep up with the Paramount (assuming the same barrel). However, once you leave the world of "custom made ammo" and go to the arena of "here's your box of bullets mate, go shoot them," things would promptly change.

Well, since the debate was based upon "shoot from the hip" (sorry, no pun intended) assessments, I thought I'd try to be a little more scientific about it after I got home. So, a couple of months after returning from New Zealand, off I went with test loads in hand.

Unfortunately, I no longer had a Palma barrel on a Winchester action. Back in 1992, when I went to the World Palma Championships in Raton, New Mexico, I had a 30" 1-13 Obermyer barrel mounted on a M70. The "plan" was to use this rifle for the Palma and then, after Raton, it would become my "across the course" rifle. The plan worked well (although I could only shoot 155gr bullets from this barrel) and the rifle served me well during that transition to a "pure bolt" gunner and long range fanatic. Subsequent to going to New Zealand, I had the Paramount rifle built as the "real" Palma rifle and put a 1-10" barrel on the Winchester to give me a greater selection of bullets for other competitions. For those of you who are considering shooting long range and across the course but don't want or can't afford 2 rifles (yet), this is the perfect compromise and I highly recommend it. The only drawback, if you consider it one, is that you will find the 1-13 twist barrel can't shoot anything but the 155's well.

Anyway, back to the comparison. From 1992, I still had some examples of



GROUP A
1.189 x 1.188

groups shot with the Winchester M70 using the same Palma load that was used in Raton, NM. This load was 44.8g of IMR 4895, a Winchester case and a F210 primer with a Sierra 155g Palma bullet. Group A shows how it shot in the M70. Next to it (Group B) is a load that was "tailored" for the rifle and you can see a better group.

Group C shows the same 1992 Raton Palma load shot in the Paramount rifle. As you can see, somewhat better than the Winchester. Group D is the "tailored" Paramount load and you now begin to see a significant improvement.

Finally, Group E is the ammo that was provided in New Zealand and shot through the Paramount. Unfortunately, as I said, I no longer have the Winchester with the Palma barrel so I cannot provide a comparison. All the groups were fired at 100 yards off a rest and with iron sights.

Scientific? No, and I'm sure the true benchrest shooters are going nuts with my less than consistent approach. But all that notwithstanding, and in spite of the fact that I shoot a Paramount and may be biased, I'm still convinced that the original debate is correct. That is, when using issued ammo, not specifically made for the rifle, the Paramount has the advantage over the Winchester.

THE NUTS BEHIND THE BOLTS

Anyway, enough of this scientific stuff, let's get back to the real shooting story.

One of the interesting things about the conditions in New Zealand, as well as Canada and Bisley, is that they change radically and quickly. Even though all of us have experienced similar conditions at other "home ranges" these are "different." The record at New Zealand was 13 minutes left wind to 6 minutes right wind,

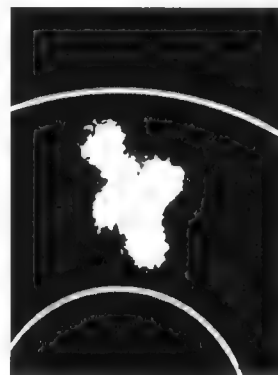
Continued on next page



GROUP B
.741 x .716



GROUP C



GROUP D



GROUP E

The Odyssey of The Fourteen

Continued

back to 8 minutes left wind! This was within a 4 minute time span and please note I said MINUTES not CLICKS (ask Dave Brantner about this, he has a real interesting perspective). (Editor: Yes, but is it printable?) Well, remember my earlier comments about "convertible sighting shots?" This was probably when you thought to yourself something like "real men don't do convertible shots." Let me tell you, under these conditions you don't want to shoot any more than you need and, if your first sighter is a "10" (or a V bull) you want to take it. The logic is, you shot it, why shouldn't you have it. Personally, I knew this was a great idea the first time I was able to say "I'll keep the '10' but throw away the '7'."

OK, it's time to talk about how we did. In a nutshell, we all did fantastic but, to put it into perspective (another term for rationalization) let me give you "the big picture."

In the 3 day Individual World Palma Championship held the 2nd week, the highest possible score would have been a 1350-135x. There were a total of 238 people who competed and the event was won by Tony Ringer (who ain't human) of Great Britain with a score of 1312-51. (In the interest of accuracy, no pun intended), the top 10 shooters participated in a "shoot off" of an additional 15 rounds at 1,000 yards. I've subtracted that score so you can see how the top 10 compare with the rest of us).

The top U.S. shooter, who was also a member of the US Palma team, was Eric Pintard who fired a (corrected) score of 1303-52 and ended up being number 3 overall. The top place of the "Independent US Shooters" (that's us) was Bob Gamboa. Bob ended up being ranked #55 in the world with a score of 1283-43. The rest of the Independent shooters, in rank order were: Peter Church (1259-31), Forest Browning (1246-22), Tom Lintner (1242-28), Mark Sproul (1237-31), George Hutton (1229-28), Dave Brantner (1221-38), Carol Sproul (1217-23), Earl Liebetrau (1201-22), Steve McQuain (1194-22), Dick Wyatt (1175-22), and Noel Sugden (1137-13). We ranged from #55 to #213 and still had 25 shooters who finished behind the last Independent shooter! Folks, let me tell you, that's not bad for a group of people who flew half way around the world to a range they never saw, with wind that would blow you down, to go up against the best.

By the way, how was the competition you ask? Please, let me tell you...In one match Bob Gamboa shot a "clean with 8" and ended up TYING for 1st. In another match, I shot a "clean with 5" and naively thought I'd be "right up there"..WRONG, how about number 47! Probably the best story was the outstanding performance of Dave Brantner on the first day at 1,000 yards. With the wind going from 10 minutes right to 8 minutes left, back and forth, Dave shot a 146-6!! Although he took the 1st place gold medal with this score, Dave had left before the daily awards ceremony thinking it wouldn't be good enough for anything!

Finally, there are a number of "human interest" stories associated with this great adventure. Most of you, especially in the Virginia area, already know about Bert Rollins of Fairfax, Virginia, coming home as the high shooter on the US Team during the Palma Team Match. What is not known is that Bert has played a major role in gaining support for the Palma Team and the event itself. He is the Vice President of a non-profit organization that is dedicated to fostering this type of shooting and wants everyone to have the opportunity to enjoy the adventure of long range sports. In my case, Bert played a major role in providing me with some much needed logistical support, without which my ability to join him in New Zealand would have been questionable. Thanks, Bert.

Then there's John Knight. This man is probably the best gunsmith and source of sage advice on the east coast. John, who learned gunsmithing through the "School of Hard Knocks" and does not do gun work for a living, specializes in "across the course" and varmint rifles and conducting some wild experiments with rather unusual rifle/caliber combinations here in Virginia (how about a .22-250 for 1,000 yard matches and achieving high master scores!) When I started to panic at the last minute before leaving, John was there, to the wee hours, to make everything work (Special Note: John, the late night Chinese dinner didn't even come close to thanking you for rechambering my #2 rifle in 4 hrs). If anyone ever considers shooting bolt guns competitively, talk to John first. You'll come away with an education that most people pay \$600 a credit for. In an upcoming article called "The Great Gunsmiths of the East and West" you'll read more about this man as well as Bob

Gamboa, and some of the great long range rifles they've built.

THE EPILOG AND BEGINNING

Finally, where do we go from here? I mentioned that Bert Rollins is the Vice President of Palma Promotions. The President, and a driving force behind the quest to get more US shooters involved in international long range competition, is Dave Fiehtner, a former Navy Rifle Team coach and shooter.

Palma Promotions has already begun the process to develop a reference source of contacts, phone numbers, schedules, etc., of many of the major events around the world. Planning has already started for the next National Match in South Africa in anticipation of the next World Championship Palma in Bloemfontein South Africa in 1999. Additionally, the "Millennium Meeting-2000" is being planned for Bisley in the United Kingdom. I have been asked (and foolishly agreed) to serve as the International Coordinator for Palma Promotions.

By the way, for those of you who may be asking, "well, this sounds interesting, but just how much did it cost?" the total cost for the combined matches, including the Individual World Championship, plus ammo and accommodations with breakfast, was approximately US\$850.00. (Note, I've deliberately left out airfare, car rental, gifts for friends and family, the cost of your spouse saying, "now, where are you going to take ME for vacation?" and miscellaneous expenses to keep from scaring the hell out of you. But don't worry about incidentals, the important thing is not to ask how much it costs, just figure how much it will be a month!) Also, remember you have to factor foreign currency exchange rates into these estimates. In Canada and New Zealand it's like a 35% discount. In the UK, you end up paying 40% more. In South Africa you get 3 South African Rands to the dollar (that's free!)

So, if you have any interest in these types of events, or wish to help support US shooters representing the United States, please contact Dave or Bert at PO Box 0391, Sterling, VA 20167. Telephone (703)430-9308 fax (703)430-1072.

Finally, anyone can participate in this type of shooting and, although the competition is challenging, you'll have a great time. But it does take planning so call now and start to think about South Africa, Great Britain and Canada.



Palma

A Shooter's Wife's Trip to the 1992 Palma Matches at Raton, New Mexico

or

ADVENTURES OF A MODERN DAY CAMP FOLLOWER

by

Elizabeth Wessel ©

(Editor: Since the above was written, the 1995 Palma Matches of course were held in New Zealand. A major reason for our wanting to publish this particular article... which would appear to be outdated on the face of it... was to acquaint the reader with some good reasons for some day taking a deep breath... and heading for Raton. A year or so ago we published Don Ballasch's article on ancient historic spots in the area of the Super Shoot. At the 1995 Super Shoot there were so many shooters and family members out walking the fields, looking for arrowheads that Don was carrying around with him two expensive Ohio-published books on how to identify and date the area's arrowheads. I think Elizabeth had done a great job of telling the possible Raton competitor, and his spouse what to expect, and what to look for in the Raton area. So, when your little sweetheart some day loudly protests... "Me... go to Raton? What the heck is in Raton?"... keep this article in mind, my man. It just could be the item that tips the scales in favor of the trip. You're welcome, sir).

The prospect of ten days on a rifle range had very little appeal for me, but the promise of a sight seeing tour through our American Southwest, both going to and coming from the Palma matches was more than I could resist. After all, I've seen lots of ranges: Camp Pendleton, Winchester Canyon, Ojai, Coalinga, Black Canyon, Bisley, and each does have a special kind of beauty. So what could Whittington Center have?



Fred Wessel, with enough ammunition for whatever little problems might arise in the course of the day.

What but the usual hundreds of yards of dirt, fringed with 100 targets bordering them like jagged teeth of a Jack O'Lantern and the usual irritable husbands amid a group of otherwise gracious people.

We crammed our 26-year-old Black Car with a minimum of clothes and a maximum of shooting gear and left coastal Southern California Sunday for a leisurely three-day drive to New Mexico. Our first stop was Laughlin, Nevada, a gambling mecca on the Colorado River where the beauty of Black Car drew its share of attention away from the ornate, elegant hotels and casinos. The temperature was only 112 degrees when we pulled into Laughlin, and with a predicted

temperature of 117 on Monday we did very little but sleep there. We left before breakfast or even a morning swim to get to the higher, cooler altitudes of northern Arizona. We had a nice breakfast in Kingman, and a beautiful comfortable drive to Flagstaff where the temperature was a more acceptable 90 degrees. We were delighted with the lovely part of Flagstaff we saw, the clean air, majestic ponderosas, and the spacious uncongested rural shopping area where we stopped at a friendly Arby's for a better than average lunch.

We dodged afternoon thunderstorms as we made our way to the massive Meteor Crater — 3/4 of a mile in diameter and as deep as the Washington Monument is high. The crater was formed about 30,000 years ago, and because of its similarity to the moon's craters it was used by the astronauts as training ground for their moon walks. The afternoon thunderstorms made it an even more impressively awesome sight. When the rains let up we continued on our way to the Petrified Forest with its beautiful rocky knolls, brilliantly colored petrified fallen logs, Indian ruins and petroglyphs. The side road for this trip also led to the southern part of the Painted Desert. The late afternoon sun breaking through the storm clouds gave it an unearthly beauty. We continued into Gallup and as daylight faded the flashes of lightning became even more spectacular. The rain held off until after we were settled for the night.

On Tuesday we again drove awhile before stopping for an excellent break-

Continued on next page

A SHOOTER'S WIFE'S TRIP TO THE 1992 PALMA MATCHES

Continued

fast in Albuquerque, then headed north toward Santa Fe. The heat of the day and the increase in altitude had a detrimental effect on Black Car's carburetor whose sea level setting was too rich for the thin air at 8,000 feet. Twice we stopped at rest areas and twice it took us about an hour to cool the car enough for the gasoline to stop boiling out of the carburetor. Even with these setbacks we were able to check in at Whittington Center about 4:00. We were given a gate pass and a map of the range, then took a quick drive through part of the 33,300-acre facility. Because of a misunderstanding we had made hotel reservations in Trinidad, but decided to check the Palma headquarters motel in Raton to see if we could stay in a more convenient area and save the extra forty-mile drive to Trinidad each day. Although as a volunteer my husband Fred had complimentary accommodations at the range, he elected to stay in town with me. Luckily the motel did have a cancellation, and there at the reception desk, also checking in, was an old friend, the captain of Europe's Palma team. I was greeted warmly in his continental manner, a nice beginning to my Palma experience. We were given a comfortable room, had a good meal and a good night's sleep.

The range was open Wednesday, Thursday and Friday for practice. Throughout the rest of the week we were pleased to see a number of old familiar faces arrive. We tried unsuccessfully to have someone adjust the carburetor Wednesday morning, but all the mechanics were busy until Monday. That is why, the locals tell me, that most Ratonites drive to Pueblo to have their cars serviced. We instead drove to Whittington Center, got Fred's room assignment, his sheets and his squadding for the next three days of practice. Fred was housed in one of the log cabins near the high power range. He selected a room with double bunks, made up the lower bunk and left a distinctive towel and poncho on it for identification. There were two other rooms in the cabin, both with several more bunks, and a nice shower and bathroom facility. Other of our friends were housed in the much more elegant newer cabins with twin bedded rooms, porches, kitchens in each wing, and a nicely furnished sitting room with TV. There are also campgrounds, both primitive and with hookups and showers, a



The "Black Car" mentioned throughout the article... with either affection... or frustration... depending upon the circumstances of the moment.

dining hall, and classrooms. There was a sighting-in range, and on the 1000-yard range there were electrical hookups on each firing line for phone and PA systems, plus a portable Cape Cod style control tower which was towed from firing line to firing line, and the best designed target frames I have ever handled. Most of the competitors took advantage of the three-day practice period and I helped where I could by pulling targets, toting equipment, and fetching food. And I got acquainted with many of the terrific people who showed up to compete, help or just watch. One of the first I met was Leslie, a young woman fairly new to competition but quite competent. While her two children were vacationing with their grandparents and her husband had temporary duty outside the country she drove alone from Virginia to participate in the matches. The drive took her two days! A couple of angels from Oregon had come in two weeks early to make the hundreds of targets needed for the matches. They were still working at all sorts of tasks with the efficient group of NRA staff members, plus many non-competing temporary staffers from all over the U.S. who were directing activities at the range, consistently helpful, consistently pleasant. We made friends with retirees, ranchers, music teachers, doctors, lawyers, you name it! Many of the foreign team members had also arrived and we shared information about

our respective countries. The teams this year were from Africa, Australia, New Zealand, Europe (Germany, France and Belgium), Great Britain, Canada and the United States. The Africans were amazed to know that there is life and vegetation on our deserts and that we can irrigate and cultivate them. Theirs are more like Death Valley with sand dunes and alkaline soil supportive only of snakes and lizards. One woman, expecting Raton to be desert was surprised to find the area covered with prairie grass and wildflowers. Indeed, Whittington Center is the most beautiful gun range I have ever seen — lovely mountain meadows 8,000 feet high with wooded hillsides scattered throughout, streams bisecting it and guarded by the distant Rocky Mountains. The entrance to the range is lined with flags of the participating states and countries waving their welcome. A short distance from the entrance is a plaque marking the Santa Fe Trail which parallels the eastern boundary of the range. To the west is a canyon with a ghost town and abandoned mine, all part of Whittington Center now. The air is clear and thin, clouds caress the land in the morning, threaten it with thunderstorms in the afternoon and shine brightly in the evening lighting. Although I never saw them, people told me that deer would come in the late afternoon and watch the shooters. I did see plenty of birds, prairie dogs, squirrels and lizards.

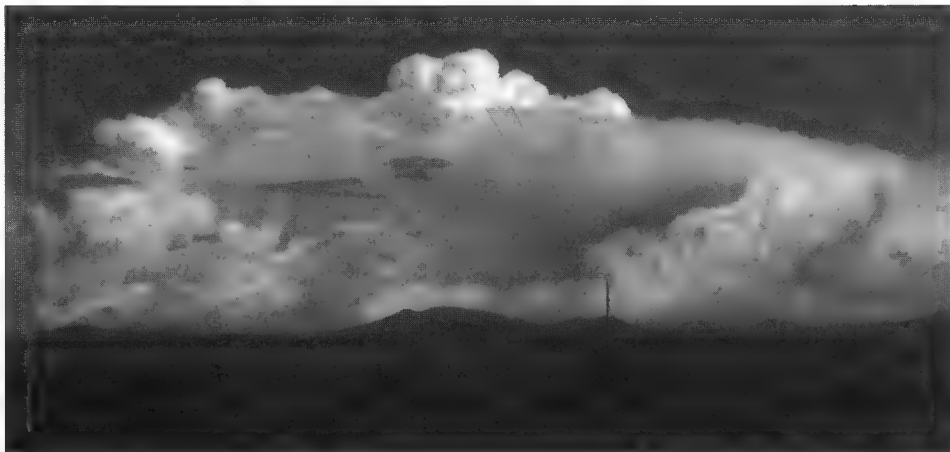


George Tubb... father of PS columnist David Tubb, and the gentleman for whom the range at Raton was named.

We found at this altitude that our zeros were a bit different than at sea level, but with very little effort Fred and his buddies had their rifles properly sighted. Satisfied with his rifle, sights and bullets, Fred then tested the official Palma ammunition against our carefully weighed and assembled hand loads and was pleased with their quality. Mr. Jensen had apparently done a very good job.

Fred was now satisfied with everything but the limited windage on his gun sight. He had asked O. K. Weber to bring a new sight for him, but meanwhile managed to fall in love with an extremely sensitive sight made by Warner Instruments (18 Lucinda Terrace, Keene, New Hampshire 03431). It has increased windage and Fred thought it just might be the best on the market. It turned out that Alan Warner had a room right above ours and was kind enough to sell Fred the sight and properly adjust it to his rifle. So much for zeroing the rifle! Fortunately the sighting-in range was open on Saturday and we already had the proper targets. We headed to the range, picked up an interested couple from Kansas, and again went through the process of getting absolute zeros. The other men at the range were all wonderfully cooperative and helped us with spotting and target settings. Before we were finished we were joined by Canadian Palma team members whom we had previously met at Bisley and had a joyful reunion. We left the range when the usual afternoon rains started.

The official opening reception was that night at our motel. There was free Coors beer and masses of splendid competitors in their team uniforms. They looked quite dashing; green jacketed Europeans, navy blue English, red, white and blue Ameri-



If you like mountains... and spectacular cloud formations... Raton is the place to be!

can, etc. A few women team members were present. They distinguished themselves during the following week with several wins.

The individual matches started Sunday at 8:00 AM. It was a beautiful clear morning. The center targets and the ten at each end of the line were not used. Fred was on target 85, relay 3. He was paired and surrounded by other "W's" which indicated that target assignments were given alphabetically. His relay had pit duty first while relays 1 and 2 shot at 600 yards. The relays changed for 3 and 4 to shoot the 600 and 900 and again for 1 and 2 to shoot the 900 and 800. Before they started the 800 the rain came down in buckets with strong winds driving it downrange. Relays 3 and 4 were able to stay dry in the pits while 1 and 2 had to

Continued on next page



Dave Milosevich, PS columnist, and Highpower bolt-gun chapter author for the PS Reloading Guide (advertisement), complete with his usual railroad engineer's cap.

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A SHOOTER'S WIFE'S TRIP TO THE 1992 PALMA MATCHES

Continued

fight the elements. There was a second heavy shower during the next pit change but it was over by the time the shooting started again. Fred and his relay had only the wind to contend with. His new sight was put to the test and passed with flying colors. He was pleased with the sight and the score.

That night while hurricane Andrew was demolishing Florida, hurricane Lester moved into New Mexico. Fred packed up and went to the range at 6:00 AM the next morning. I stayed at the motel listening to storm and flash flood warnings for northern New Mexico the entire day. The shooting was cancelled and the scheduled matches were postponed until later in the week. Fred came back about 9:00 AM and wanted to go to Taos to ride the narrow gauge scenic railroad. We left immediately for the double treat of more breathtaking scenery and the charm of Taos. By the time we reached Cimmaron we realized that there was no way we would get to the train for its 10:30 departure, especially as the depot was in Chama, some 40 minutes past Taos. After this we took a more leisurely pace through the Cimmaron River valley, the Palisades, Eagle Nest, Angel Fire and eventually to Taos. The beauty and peace of the area led me to wonder how Billy the kid and his cronies could live amid such loveliness and lead such a villainous existence! Fred was drawn to a stretch of river which had a special fishing designation and started planning a fishing expedition for later.

Fred's first impression of Taos was unfavorable. Traffic crept past Kit Carson's house and the many art galleries in the town center. He labeled it a tourist trap, headed for a gas station to fuel the car, and to a restaurant for a good but expensive buffet lunch. We continued on the road to Chama as far as the Colorado River Gorge where one of the highest highway bridges in the United States crossed. The thunderstorms had started again so we prudently turned around and headed back through Taos to the Mission of San Francisco de Asis, which I personally found less than beautiful, then back to Raton through the majestic Sangre de Cristo mountains. Frequent thunderstorms accompanied us.

Tuesday morning at 8:00 AM shooting resumed in spite of the overcast sky. I stayed in Raton, did some marketing at a local plaza and then hiked the mile into

downtown Raton for the self-guided "Historic Walk." Many of the turn-of-the-century buildings had outstanding features which really make the walk worthwhile. Across from the Santa Fe Mission-style railroad station is the local museum, newly painted a bright pink. Mike, my host there, pointed with pride to the excellent new Civil War display and made sure I saw the video on the Confederate Army in New Mexico. Although I did not find the museum as informative about the area as I would like, it did have many nice pieces of furniture, clothing, crystal and photos of families, but unfortunately no write ups to introduce the stranger to these families. Mike showed me a recent newspaper clipping about an auction featuring the elegant leaded glass entry door, crystal chandelier and huge bar from the corner Palace Hotel, and then directed me to the Shuler Theatre where I was to ask Gerald for a personal tour before going to Michael John's for lunch. Gerald was out to lunch when I arrived so I explored the lovely little theatre alone, finished my walking tour and decided on lunch at El Matador. I enjoyed the classic enchilada immensely, then after a short stop to look in a local art and jewelry shop I headed back to the motel. I learned that the Indians do not like to sign their works because they feel man would be presumptuous to put his name on work inspired by God. Man is only the craftsman; God is the creator.

I returned to the motel early enough for a swim with my very young English neighbor Andrew. When Fred returned from the range he wanted to see the Raton I had seen. After treating Black Car to a bath at the local do-it-yourself car wash we drove the route I had walked



Dave Milosevich, PS columnist, with Mid Tompkins, Palma Team coach and noted Pepsi authority. "I tell ya, David, this year's Pepsi is way too weak. I've been adding a full ounce of Shooter's Choice to every can, and shaking well." "Jeez, Mid, that's pretty wild. How do you feel these days, anyway?" "To tell the truth, better than when I was adding Sweet's to it."

that morning. Wouldn't you know, I had missed the pawn and gun shop! This was a must-see on Fred's list. We had a long stop there, went to the Shuler Theatre and met Gerald who sold us tickets for Thursday night's performance. We had dinner at Fred's favorite restaurant where the owner gave us frisbees for Andrew and a friend's daughters. Next time we come to Raton we will probably stay at their motel.

Like a good camp follower I went along to the range Wednesday and Thursday. Fred was very pleased with the way his new Warner sight performed and his scores continued to improve. One friend was delighted with a \$10.00 win and another with a third place, quite an accomplishment in this field of experts. Another friend who holds several state's championships figured he was 11th among the U.S. shooters but 122nd overall. At the close of the individual competitions on Thursday the top score was 73 points less than a possible 2400. The winner of one match had 200 with 17 X's. Even a perfect 200 score wasn't award winning without more than half the shots in the X ring.

With competition now behind him, Fred and I relaxed over an excellent Italian dinner at Michael John's before

our date at the Shuler. The play was an original musical "Born of the Sun" based on episodes in the lives of Kit Carson and Charles Bent in their early days in New Mexico. The authors took liberties with historic facts but created a remarkable piece of theatre never the less.

The International Palma matches started Friday with a day of practice for the team members. We had to be at the range early as the state road into Whittington Center was subject to closure at 7:30 for repaving. Fred had pit duty but no target assignment; he was relief man. The practice went very slowly. One target crew started a \$1.00 lottery. We would stake out a quarter size spot on the target and the closest spot to an actual shot would win the pot. We didn't win. The day at the range ended early enough for us to wash the car again and for me to have a quick swim before dressing for the awards ceremony and banquet. Usually on my way to the pool I would visit with the shooters cleaning their rifles; this time I dodged the cameras preparing to immortalize the teams in their formal team attire.

Shooters really know how to have a barbecue and our banquet was one of the better ones. After dinner the awards ceremony opened with a brace of boys carrying a flag through the hall, followed in turn with the flags of each competing nation. It was simple but very effective. Cash prizes and gold, silver or bronze bolos were awarded for first, second and third place winners. England had the most winners but all of the shooters and guests enthusiastically applauded and congratulated each winner whether it was the young top scoring Englishman, the turbaned giant who looked like a Sikh, the erect slim black African or the American woman. The fellowship among the sportsmen was impressive. After some very brief remarks by NRA and local officials the Indian dance troupe performed. They were beautifully costumed in feathered outfits which may have been authentic, but I have my doubts about the Indian roots of some of the very blond dancers.

The Palma Team matches were on Saturday and I had to miss them! Our windshield had been cracked by flying rocks from the road paving operation and Fred had arranged to have it replaced in Raton at 8:00. I took him to Whittington at 7:00 and left him in the pits with a cooler, a carafe of tea and plenty of food. I made it back to the glass company on time. I was there, the car was there, the men were there to do the work but the new windshield was not. We had all sorts

of reports of where it was and when it would arrive. I was sent back to the motel to wait and the shop owner cancelled his Saturday plans so he could install it just as soon as it showed up. By four in the afternoon it became clear that the windshield just wasn't going to make it. By that time England had won the match, the United States was somewhere down the line but not last, and all the shooting was over.

We packed up and left Raton Sunday morning. Andrew's family had already returned to England, but they had a nice tour of the east coast before arriving in Raton. A young South African woman told me they had planned to go to Florida but with the report of damage done by the hurricane they were having second thoughts. I suggested Southern California which seemed to fascinate her, especially when I described the cultivation of our deserts. The New Zealanders didn't need any convincing, they already had an itinerary laid out that included the Grand Canyon, major cities in Arizona and California and then Hawaii on the way across the Pacific. They had already enjoyed a visit to Canada before arriving in Raton.

We headed north and had a fantastic trip with stops in Colorado Springs, Denver, Estes Park, Rocky Mountain National Park, Winter Park, Eagle, Colorado National Monument, Black Canyon of the Gunnison River Gorge, Montrose, Ouray in its exquisite Alpine setting, Silverton, Durango, Mesa Verde, Cortez, Tuba City, The Grand Canyon and back to Laughlin. Each place was of spectacular beauty. We took sixteen days to drive home, sixteen days of ever more beautiful sights opening before us with each turn of the road.

The entire Raton experience is one to remember, not only for the beauty of the trip but for the union of the nations competing in friendship and the fellowship of the sportsmen. In three years there will be another Palma match in one of the other team's country. I don't know yet where it will be but I do know that the experience will be well worth the trip. There can be new friendships with more beautiful people ready to congratulate their competitors, more new lands to see each with its own special beauty. I'll start saving for Palma now. Do come along. You'll love it.



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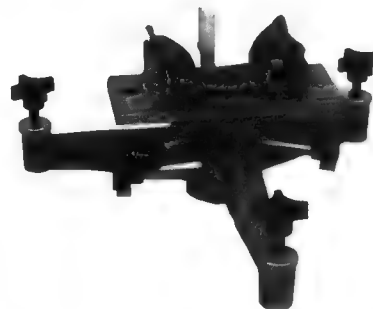
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THE SAVAGE M112 BVSS-S

by
Bob Jourdan

Savage has been a household name in our family for three generations. Back in 1915, my dad received a birthday gift of a new Savage M99 rifle in .30-30 caliber. The rifle was used regularly for over 40 years and now resides in my gun vault, perfectly shootable, but very well worn. It was the first centerfire rifle I carried on a deer hunt. By the late '50s when Savage brought out the first true left-hand bolt action rifle as a regular production model, the Model 110-L, I purchased one in .243 Winchester caliber. Then in about 1962, I gave my son, Mike, his first centerfire rifle as a Christmas gift, a M99 Savage in .250-3000 caliber. Since then, there have been several Savages show up in my gun rack, along with dozens of other makes. But the Savages seem to stay, and for one very simple reason: They are accurate. For decades on end, the lever action M99 was the most accurate lever action rifle made. When Savage got into the bolt actions, it wasn't long before dedicated shooters discovered that Savage bolt action rifles generally could be depended on to be more accurate than competitive makes, and when the cost is considered, too, there is simply no contest. Today's Savage M110, and the many variations thereof, are the most accurate over-the-counter rifles available outside the custom shops.

Last spring I was invited to participate in the Prairie Dog Conference held in Malta, Montana. One of the requirements was that I arrive with a factory rifle in either .223 or .22-250, since Winchester was furnishing ammunition in those calibers. Since I had never been involved in a big-time prairie dog hunt and had never hunted in Montana, I jumped right on the opportunity. A day or two later, I remembered that I didn't even own a standard factory rifle in either of those calibers. A quick telephone call to the sponsor of the event, Chuck Cornett, in California, put me in touch with Savage Arms, Inc., who immediately offered me the use of their new Model 112-BVSS-S, in .22-250 caliber. This is their hot new varmint rifle in stainless steel with heavy barrel, fluted and properly crowned for accuracy. The stock is laminated walnut with the good feeling Wundhammer palmwell at the grip and



1. The Savage M112 BVSS-S has a heavy laminated stock with palmwell at the grip and a nice, 2" wide flat bottomed forearm, the kind that sets up nicely on the bags.

a 2" wide, flat forearm for setting up accurately over a rest. The last "S" in the model number stands for single-shot, the best way to go with any varmint rifle. As with any well made, properly designed pure varmint rifle, this Savage is no lightweight. It weighs in at about 10 pounds, and by the time I added the excellent B&L 6x24 Elite 4000 scope, it was not the kind of rifle you would ever want to carry around over hill and dale....

When the rifle arrived, the first thing I did was pull off the stock and check the bedding. All the internal cuts were clean and neat, and the barrel groove was wide open for fully floating the heavy barrel. The recoil lug cut was very smooth and flat, and from the looks of the pressure marks, it appeared that the lug was fitted very well and proper. This is not common in most hunting rifles. Since this was a laminated stock with a glue line every sixteenth inch or so, the strength in the recoil lug cut would be about equal to glass bedding. The action screws were both socket heads and recessed, which is the way most custom rifles are done today.

My next move was to test the trigger pull, since all manufacturers are now setting them too high for use so as to make their legal staffs happy. This trigger was no exception, being set too high for my trigger gauge to record. It was probably

about 100 oz. pull, or a little more. When you are somewhat used to benchrest triggers at less than 2 oz., or varmint rifles at about 8 oz., this 100 oz. just won't do. Even my regular big game hunting rifles have pulls of 24-40 oz. The Savage trigger has four adjustment screws, one each for poundage pull, sear engagement, overtravel and safety detent pressure. Thus, the pull can be adjusted rather easily.

The weight of pull is controlled by a single spring wire along the side of the trigger mechanism with one end under a fixed pin, the middle laid over a fulcrum point, and the other end under an adjustment screw. By relieving the adjustment screw pressure all the way, the spring wire will fall out. Under normal adjusting situations this will not happen, and the screw will allow a good deal of latitude in the adjusting of the pull weight.

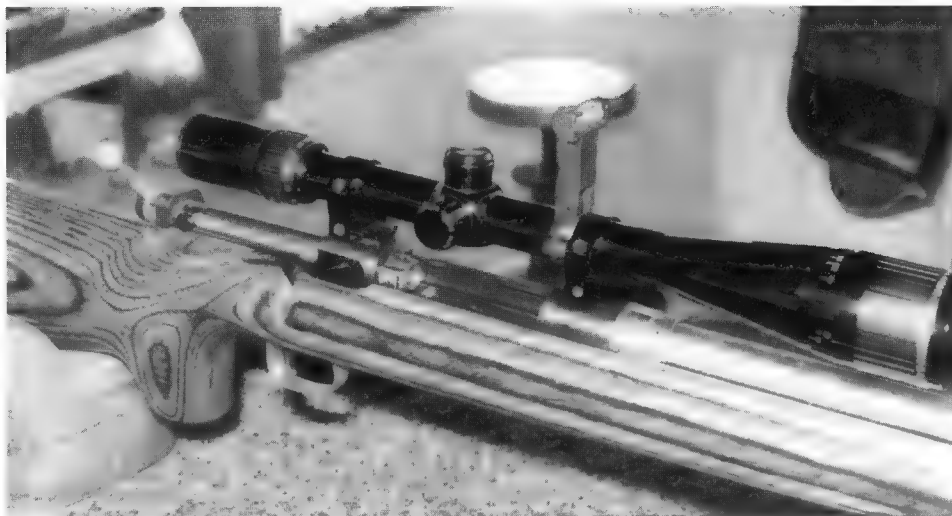
The sear adjustment is something that will deserve close attention. This screw is at the front of the trigger and drives against the sear arm that is the internal part of the cocking indicator seen on the outside of the rifle. The tip of this arm is held by firing pin spring pressure against the face of a notch in the trigger blade. As the trigger is pulled, the notch releases the sear arm for firing. By turning the adjustment screw, the arm is driven up or down the notch to change the sear

engagement. The trouble here is that the engagement surfaces of the sear depend on how well the trigger blade fits on the trigger pivot pin. Any looseness of this trigger pin will result in the trigger tilting side-to-side, very slightly. This in turn causes the sear surfaces to change their contact point. Therefore, when you make this adjustment you can not make it too fine, because later the trigger might tilt on the pin, again ever so slightly, and the engagement surfaces will change and cause the firing pin to fall off the sear. The rifle will fire.... I learned this the hard way. I originally set the trigger to 32-33 oz. pull and checked it for safety. During the test it worked very well and was safe. But after a few hundred rounds had been fired, the mechanism loosened up slightly and trigger pivot pin movement allowed the sear to disengage when I closed the bolt on a live round at the shooting range...with the rifle on the bags and pointed downrange. Yes...I was surprised.... When I tested it by slamming it open and closed several times, I found that it would not cock every time. By handling it easily, it did cock, so I went on with my testing. Back in the shop when I adjusted it to a safe position, the new safe pull checked out at 52 oz. This is not too much for most big game hunters, being close to three pounds, but is not considered good for varminting and is detrimental to accurate shooting.

The overtravel and safety detent adjustment can be set by trial and error, generally. The safety must be checked while changing these settings, or you could end up with a non-workable safety. Both screws are under the rear of the trigger, and of course, all screws are hidden while the rifle stock is attached. The bottom line here is that the trigger is very good when adjusted to three pounds plus, but anything lower requires close attention and care.

Next, I installed my good B&L 6x24 scope, loaded up some new cases with a low starting load of 34 grs. of IMR4064 behind Speer 50 gr. TNT bullets and headed to the range. There I found that the scope mounts didn't fit properly, even though they were the correct ones, according to the charts. I could not get on paper at 50 yards with the full use of the internal scope adjustments. So, back to the shop, shim under the front mount base and reverse one ring, as per Bushnell ring instructions, and back to the range. The first five shot group at 50 yards was right on, and measured only about .42", which indicated that the rifle might be accurate.

Out at 100 yards the rifle shot one



2. The only action offered is the long model capable of handling cartridges from the little short BR to the long .30-06. This is satisfactory in a single-shot, but is awkward in a repeater. The test rifle was set up with a B&L 6x24 scope with the tall Scopelvel devise at the front mount ring. The Scopelvel assures the rifle is sitting level for each shot, eliminating rifle cant, enhancing accuracy.

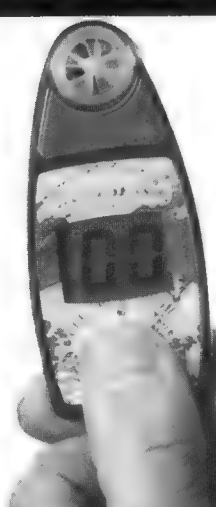
small group of .35", then started shooting wide groups of .6", .7" and .8". This usually indicates stock movement or poor bedding. Since the bedding looked good, I tried the front action screw and sure enough, it turned a quarter turn. The next group was right back in the .3s, but then started to widen again. And again I found the front screw loose. This time when turned it drove into the locking lugs effectively locking the bolt in the receiver. So it was again back to the shop. Upon close inspection I found the front screw was seated in a plastic bushing that was slowly failing. It allowed the screw to be drawn down fairly good, but after a few shots it would loosen. The reason was the slow collapse of the plastic itself. Under a glass and with a feeler hook, I found the plastic cracking and compressing. With the bolt out of the action, I turned the action screw and found that it could be continuously turned, simply collapsing the plastic as it went. There was no way the action could be bedded without a new bushing. It was also obvious that the sure cure would be to bore out the plastic and replace it with a manufactured steel bushing, or bore out the whole area and install a pillar bedding devise. I had no bushing, but did have a pillar.... In it went. Thirty hours of drying time later, I went back to the range and had only time to fire two targets before leaving for Montana. Both targets were .35". The rifle has been perfect ever since.

The Montana hunt went off very well, and the Savage M112 took its fair share of prairie dogs. The Winchester ammo

did not hit to the same point as my earlier handloads, but a minor sighting adjustment cured that. This Winchester ammo was advertised at 3680 fps, and when I got home and checked it on the chrono-

Continued on next page

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THE SAVAGE M112 BVSS-S

Continued

graph, it clocked 3694 fps on a 100 degree day, very close to the advertised speed. The targets shot for accuracy with this ammo averaged 1.11" groups, but all groups showed the same thing, three or four shots very tight and one or two off out in left field. This usually indicates bad bullets, and by handloading with custom bullets, that proved to be the problem.

For testing the accuracy of this rifle I used once fired brass, five different powders and five different bullet weights from three different makes. Twenty-four targets showed what the rifle would do. Only two of them were over one inch, being 1.18" and 1.14", and in each case I immediately reshot them with the same load to prove that the spread was the fault of the shooter and not the rifle or load. The followup targets measured .64" and .68". Counting both the over one inch targets, the rifle shot the 24 targets with an average group of .529". If the two bad targets were removed due to shooter error, the average for the rifle came to .471". This is with the mix of all components!

The general accuracy of this rifle was mind boggling. Consider that it had a 32 oz. trigger for a few targets and a 52 oz. trigger for the others, plus the fact that it was shot on rather windy days without wind flags, and you will see quickly just what I mean about the accuracy. How would it have done with a 1 1/2 oz. Jewell trigger installed, if that were possible, which it isn't? In many years of rifle experimenting and testing, I have never tested a factory rifle as accurate as this Savage M112. In fact, it is difficult to find a straight factory rifle that will truly test much under one inch groups over 20 or 30 targets. A few will show 3/4", but to get on down to the 1/2" mark is really outstanding. I have been told that some of the new factory Sako rifles in 6mm PPC will show 1/2" groups, but I have not personally seen it done. And the same is true of some .222 caliber rifles, but again, I have not seen it.

Good records for this rifle and the loads tested show that the best load would be 36 grs. of H380 behind the 60 gr. Berger bullet. The next best would be 36 grs. of IMR4064 behind a 52 gr. Berger bullet. The cartridge length as tested with the Sinclair Comparator was best for this particular chamber and throat at 3.113". The same measuring



3. The smile comes easily after testing a factory rifle that is a true half-inch shooter. The best six targets out of a total of 24 averaged .173" groups.... Amazing!

method applied to the Winchester factory ammo gave a length of 2.971".

Knowing that this Savage M112 will average an easy 1/2" at 100 yards, lets start by taking a look at the worst 25% of all the targets in the test. The worst 25% of the targets averaged .916" with the two bad targets that were shooter error. Take them out and use the replacement followup targets as explained above, and the average drops to .749". All these were shot with powders other than H380 and IMR4064. And interestingly, all these were five-shot groups. When testing a single-shot varmint rifle like this M112, there is no real reason to use five shots as a test norm. I can not remember ever getting five shots off at one prairie dog in relatively rapid fashion, but do recall a few that were dumb enough to stand around until I got off three shots.

And now for the best 25% of the targets. For an over-the-counter factory rifle, they were amazing, averaging .173" groups! The smallest group measured only .055", center to center, and the largest .248". These were shot with Berger benchrest bullets, except one that was a Speer TNT bullet. All were three-shot groups. Two were shot with IMR4064 powder, and four were with H380. This indicates that with careful load selection this rifle would be close to the mythical quarter-inch shooter....

The loading chart that is provided only covers those loads used in this test. None of the loads were tested up to the very top, where primer leaks and case marks would begin to show. But as with any load data, you should always reduce

the lowest loads by at least 5% for your starting load for your particular rifle.

Even though the Savage M110 line has spawned dozens of model changes and many different numerical model numbers, as well as variants with most of the letters of the alphabet involved, it still remains a basic Mauser design, one with a turn-bolt action with dual locking lugs up front. The barrel has no shoulder, which is unique in the firearms world. The barrel is finish-chambered before being screwed into the receiver against a headspace gauge locked in the action. This guarantees absolute minimum headspace, a 100% fit that can not be duplicated by any other manufacturer. Then a recoil lug of the Remington type, a ring affair, is dropped over the barrel and run up against the receiver face. This recoil lug differs from the Remington in that it has a detent that matches a cut in the receiver face to hold it in position when the barrel locknut is tightened against it. It can not rotate out of position when the barrel and locknut are secured, thus guaranteeing the lug will be true vertical and not canted to one side. The installation of the famous Savage barrel locknut holds things in place and is tightened with a spanner wrench. This excellent fit of the barrel is one reason for the outstanding accuracy found in Savage rifles.

The bolt is another innovative system found only on Savage rifles. The bolt body is a simple tube. The head with the locking lugs is made separate with a stem that fits into the bolt body. On this stem there is what looks like another set of locking lugs, but is really a baffle that

fills the cuts in the receiver ring where the locking lugs slide through before being rotated to the locked position. This effectively blocks off any escaping gas in the event of a cartridge case failure and directs the gas out through two relief holes drilled in either side of the receiver ring. This head assembly is held in place by a pin through the bolt body, but if you carefully inspect this, you will see that the bolt head can wiggle. This means that the locking lugs can move slightly to guarantee a perfect fit against their seats in the receiver ring when closed tight against a cartridge. The tremendous blow delivered by the firing of the cartridge will find both locking lugs firmly against their seats, right where they belong. In competitor's solid bolt heads, if the lugs are not even, which is the most common case, only one lug will seat. This causes a terrific twist in the bolt head when the cartridge is fired. When you find poorly seated locking lugs combined with chambers that are not closely fitted, you lose a considerable amount of accuracy. Savage has built-in corrections for this.

Another important accuracy feature of the M112 Savage is the manufacturing of their barrels. They are one of the very few companies using a button-rifling machine, the same as is used by most all benchrest barrel makers. This method requires more time during production, but the end result is superior to barrels made by the hammer forging system used today by most other rifle manufacturers.

Even though Savage has a winner in the M112-BVSS-S, there are things that need to be improved, the same as on other manufacturers products. First and foremost is the trigger. This trigger is a throwback to the old days at Savage, back in the late '50s, when their only goal was to design a hunting rifle that could be produced profitably and meet the needs of the average big game hunter. While the trigger proved satisfactory for most shooters, there were improvements made in the early '70s. Even then it was intended to be a big game trigger, one that would do well when adjusted down to about three or four pounds pull. With the recent explosive growth of accuracy shooting, be it varminting or target work, that trigger fell out of the running for the most part. While it could be tuned to do the job at perhaps two pounds by some shooters or gunsmiths, the average buyer tended to leave it alone, just putting up with the heavy pull. The new M112 rifle deserves a top-flight trigger and one that can be easily changed out to those

.22-250 REMINGTON

SAVAGE M112-BVSS-S, 26" BARREL

BULLET WEIGHT	STARTING TEST LOAD POWDER/CHG/VEL/CASE				TESTED LOADS CHG/VEL/CASE/TEMP.				NOTES
50 gr.	AA2520	37	3953	W				98	
	IMR4895	35	3768	W	37	3980	W	98	
	H414	38	3515	W				98	
	H380	36	3497	W	38	3672	W	95	Accurate .214".
52-									
53 gr.	H4895	35	3811	W				98	
	H380	36	3520	W	38	3640	W	94	
	IMR4064	34	3540	W	36	3740	W	93	Accurate .128".
55 gr.	AA2520	35	3710	R				98	Not accurate.
	H4895	35	3742	W				98	
	H380	36	3579	W	38	3717	W	96	
	H414	38	3509	W				98	
60 gr.	H380	34	3308	W	36	3442	W	95	Accurate .055".

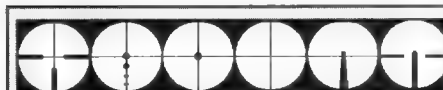
excellent after market jobs like the Jewell, Hart, Shilen and others, all capable of being adjusted down to as little as 1 1/2 oz. pull. For this to come to be, Savage would have to do a major change on the design, including a change on the firing pin cocking piece, to make it compatible with triggers that utilize the Remington pin spacing, which is what most accuracy rifles are using today. In view of the shooting ability of these latest Savage rifles, I would not be surprised at all to see this trigger change being made some time in the near future. The rifle would become a world contender....

Another change that I understand will be made immediately is on the action screw anchoring in the stock, the weak plastic bushing being changed out to something substantial. When I had the bushing failure on this rifle, the only method immediately available to me for the repair was the installation of a pillar through the stock. It totally corrected the problem and was rather easily done. Since this stock is the heavy, laminated style, it surely deserves the best bedding. If I had my way about it, I would pillar bed both action screws and then advertise it as being the only pillar bedded stock on the market today. Sales would run away.... Profits would soar.... Shooters would swoon....

Did I mention that the only action offered for this M112 is the so-called long action, regardless of the cartridge length? Since it is a single-shot, it doesn't make a lot of difference, but Savage did have one of the nicest short

actions on the market until recently. I agree with many shooters that it should be brought back. As I recall, the short action was always made as a repeater with magazine, but originally, so was the long action. My short actions were always my first choice for varminting and really for informal target work. My favorite was in .243 Winchester caliber, and I totally shot it out in just a few years. It was used for prairie dogs, coyotes, javelina hogs, white tail and mule deer, and started out being a 3/4" grouper, but ended up doing well to keep three shots inside 1 1/2". It only lasted about 12,000 rounds.... This slick little action would be something as a single-shot, simply by not cutting out for the magazine. Wouldn't it make a great .22 BR or 6mm PPC? Heavy barrel...laminated stock...quarter-inch groups....

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MYTHS ON AGED AMMUNITION REVIEWED

by

Norman E. Johnson

The myths and implicit beliefs surrounding the remaining effectiveness of aged ammunition and components are widespread, and some of this mentation is quickly shared by those whose written words are often accepted as gospel.

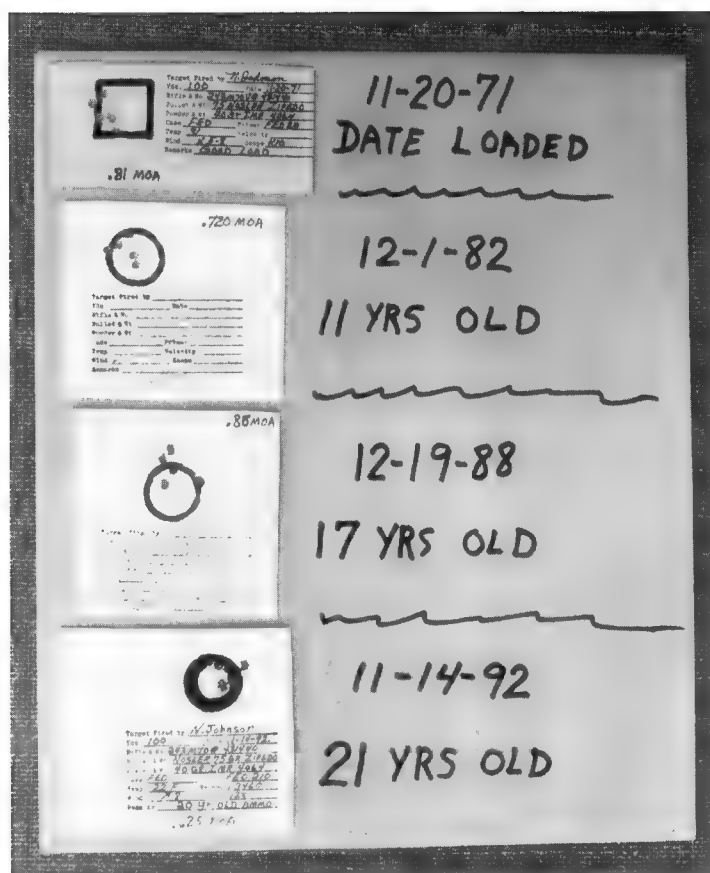
While the proper storage of ammunition or components is a wise practice, such components in original containers, as well as loaded ammunition, appears to withstand extreme misuse and neglect, including the ravages of time. Old habits and beliefs die hard, leaving some hunters and shooters with the ingrained thought that only fresh ammunition and components will measure up.

Since 1959 I have documented results of ammunition performance including the effects of aged ammunition and ammunition made from components of advancing age. This treatise is not, however, an attestation as to the prepotency of any particular brand or type of ammunition or components relative to the effects of age or condition. In some cases the research and experimentation described herein involve the fortuitous findings surrounding ammunition or components I happened to have on hand or had direct access to with no preference to brand. Some of these experiments and findings have included the use of special rifles and conditions which I will allude to as I discuss individual tests and results.

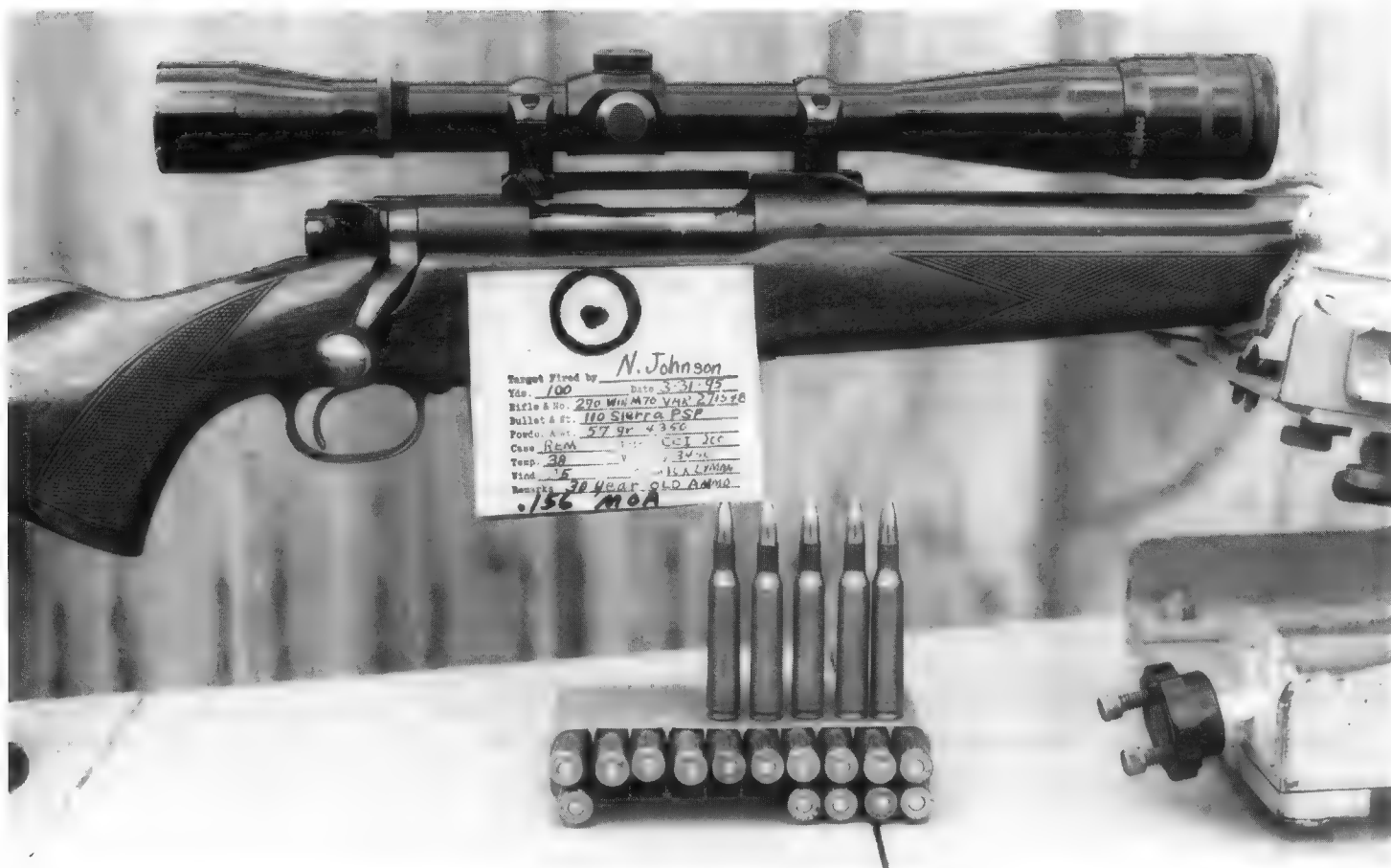
A good case in point involved the performance of some .270 WCF ammunition which I had on hand for one of my model 70 Winchester rifles. The result of this test proved to a number of shooters who witnessed it that not-so-fresh ammunition can, indeed, perform.

The date was 1975, and after a meeting the conversation turned to the performance of ammunition that sets on the shelf for long periods of time before use. Lots of the local hardware stores had some old boxes of stuff dating back many years, and the hunters would shy away from it. "Simply too damned old... won't shoot," they would say. Anyway, one thing led to another and several of the guys wanted to see if I could back up the statement that my 10 year old .270 ammunition would still shoot well. Most of these fellows knew guns and were avid hunters, but by no means benchresters. If they could hit a distant whitetail or an occasional 300 yard fox or coyote with their best rifles they were happy. My young son took a special target out to the 400 yard line with his trail bike as the fellows viewed the distance in awe. I had centered a four-inch square bullseye exactly 21 inches down from the top of the target paper to coincide with the precise bullet drop from my normal 100 yard zero to impact at 400 yards. From my ammunition room I brought out a dated box of .270 ammo which showed it to be 10 years old, loaded in 1965. The load consisted of 57 grains of IMR4350

powder and a 110 grain Sierra PSP bullet and a Federal 210 primer. The rifle was an older model 70 Winchester varmint model rebored from .220 Swift to .270 WCF by Atkinson & Marquart Rifle Company. The barrel had a special 1:12 twist and was uniform end-to-end. The rifle always places its first shot well within the group from a clean, dry bore. There was but a hint of following breeze as I touched off the first of five shots. Following the first shot I could see no bullet hole in the white target through my 10 power Lyman All-American scope, but I can't always read holes at 400 yards with a back-lighted target, so I couldn't be sure of impact. Following the five, slow-fire shots my son retrieved the target. I hadn't seen a single bullet hole in the white target and was a little concerned, as the bullseye was placed within six inches of the bottom of the paper. But jaws really dropped as the target was displayed. The shots were all well within the four-inch bullseye with an extreme spread under three inches. Now to you bench rest boys this is no great feat of shooting, but to take a rebored factory rifle and 10 year old ammo, you couldn't tell these onlookers otherwise. A few of



1. Tests on .243 Winchester ammunition handloaded 11-20-71 and fired on date of loading, and again at 11, 17 and 21 years. As described in text, groups were .81 MOA, .720 MOA, .850 MOA and .625 MOA respectively.



2. As described in test, this .156 MOA group was fired with 30 year old, handloaded ammunition. Load used was 110 grain Sierra PSP bullet, 57 gr. IMR4350, CCI 200 primer and Remington brass. Rifle used was rebored Pre-64 70 Varmint rifle from .220 Swift to .270 WCF with special 1:12 twist.

them thought fortune must certainly have lent me a hand. The word got around about that rifle and what it did that day, of which I am still occasionally reminded.

I don't get to shoot all of my loaded ammunition on a regular basis and a few of the dated boxes sometimes acquire considerable age. As my tests on aged ammo and components progressed I purposely kept back a few boxes which I would use to further my research in this area. Then on March 31, 1995 I once again put the old rebored .270 Model 70 across the bags — this time to demonstrate the performance of ammunition three decades old.

One might suspect that the chemistry within the walls of these aging cartridges most certainly would have undergone some adverse changes by now; a load that devolved into hibernation that long could hardly be awakened again. But this was not the case. From a cold, clean bore this load shot its smallest group ever at 100 yards, measuring .156 MOA, and the latent velocity was still there at 3450 fps, essentially unchanged from its original loading. Not too bad for 30 year old ammunition.

Observing the Effects of Aging Powder

As handloaders we are told to observe untoward signs of aging and deteriorating powders and discard those that are

suspect or in such condition. It is said that a distinguishable putrid odor accompanies powder on its way out. To date I

Continued on next page

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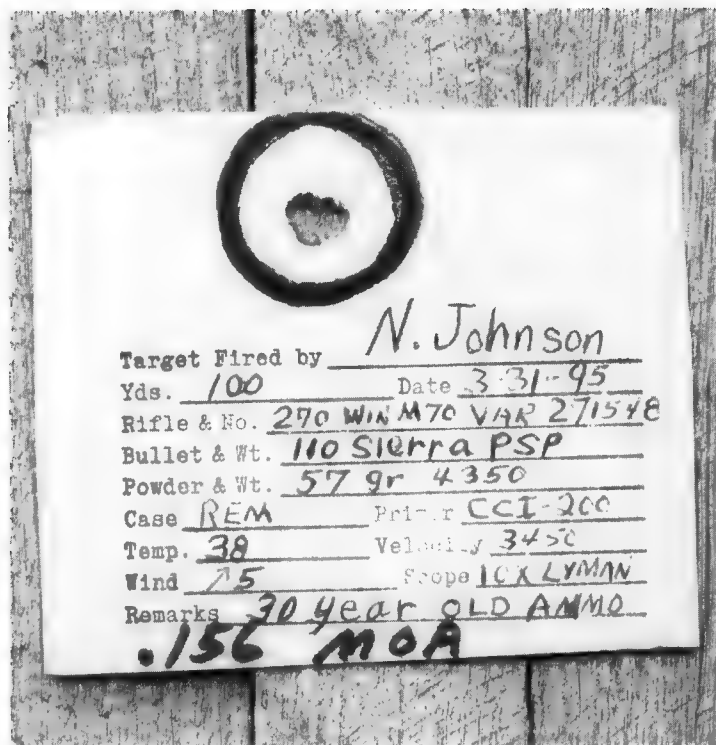
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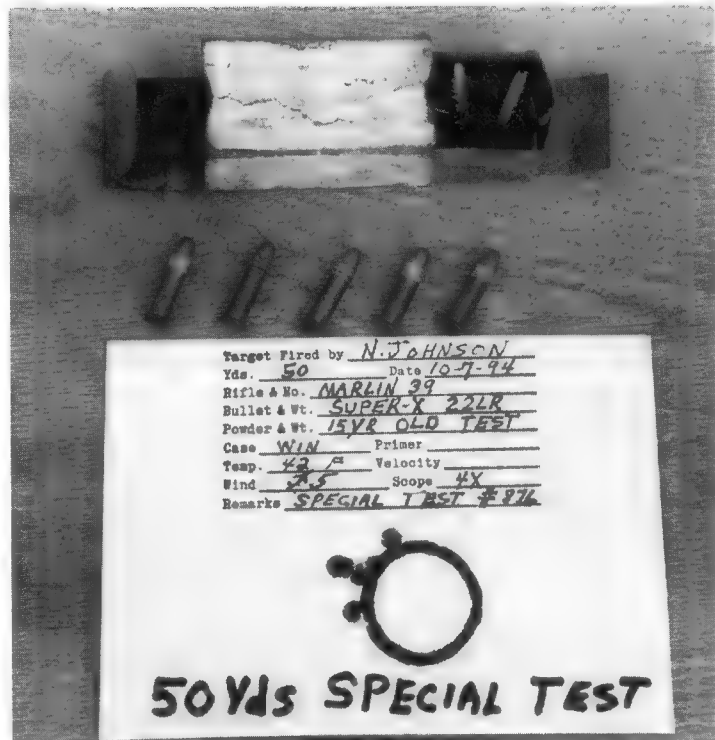
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3. Enlargement of group described in photo no. 3.



4. .22 Long Rifle ammunition tested after 15 years. Ammunition was kept for entire time on dash of ungaraged truck. (Described in text).

MYTHS ON AGED AMMUNITION REVIEWED

Continued

have had no powders that have shown this telltale sign, nor any that have failed me in performance with respect to accuracy or faulty ignition.

A good friend of mine — a renowned writer/shooter/handler reports on page 86 of the 1995 HANDLOADERS DIGEST of his first hand experience in dealing with surplus rifle powder. He just happened into his garage where he saw a can of surplus powder smoking furiously. He quickly tossed it out onto the driveway where it reportedly burst into flames. I am not totally informed on the phenomenon surrounding spontaneous combustion of smokeless powder regardless of storage conditions or on the exact chemical changes as smokeless powder deteriorates. Perhaps dwelling in a vacuum of ignorance in such matters could place us at some risk.

I can quote verbatim from a catalog of at least one company regarding their feelings on surplus powder longevity, which states: "The only low priced powders were bought for 5¢ a pound after World War II because the government knows that powder deteriorates rapidly and for accurate velocities cannot use old powders... they must make it fresh."

Of course these folks were selling fresh gun powder. Such a statement also makes my findings most interesting. In my own tests of military surplus powders manufactured around 1945, thermal efficiency remains excellent with respect to generated heat energy and velocity per unit of weight. That is to say, velocity per grain of such properly stored, older powders compare very closely to similar powders produced today. I.e., fps/grain can be depended on with thermal efficiency level essentially unchanged.

As part of my ongoing tests of aged ammunition or components or those subjected to some form of abuse or neglect that may hasten or influence resultant performance, I will relate to some .22 long rifle ammunition.

For a period of 15 years a partial box of Winchester .22 long rifle ammunition had remained just inside the window on the dash of an ungaraged pickup truck. Temperatures in excess of 130 degrees Fahrenheit and as low as minus 32 degrees Fahrenheit prevailed over this period with air humidity ranging as low as 10% to over 90%. In 1994 I tested some of this ammunition in one of my scoped .22 rifles. The ammunition box was totally bleached by the sun and elements. The

protective wax on the bullets had vanished, leaving corrosion on some of them. On testing the ammunition, there was no dysfunction including misfires or measurable velocity loss as noted by chronograph readings. Accuracy of this .22 long rifle ammunition produced five-shot groups just under an inch at 50 yards which compared with currently manufactured ammo of the same brand shot in this rifle.

Further proof ammunition can stand the test of time was displayed in controlled tests using some handloaded .243 ammunition that I had kept for 21 years and tested at intervals since 1971. The .243 load was made up using 40 grains of IMR 4064 powder, Federal 210 primers and Nosler 75 grain Zipedo bullets. The ammunition was loaded and first fired in November of 1971. Typical accuracy at that time using a model 70 Winchester (Pre 1964) varmint rifle showed one of the better groups measuring .810 MOA.

Subsequent group testing results revealed a .720 MOA grouping after 11 years; .850 MOA groups after 17 years; and a .625 MOA group 21 years later on November 14, 1992. This ammunition

Continued on page 28



5. Remington 40X Target rifle used to test some of Herter's 30 year old loaded ammunition. As described in text, respectable groups were fired under one MOA at 100 yards for three consecutive five-shot groups.



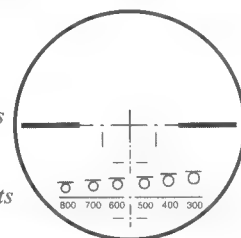
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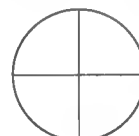
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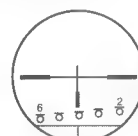
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MYTHS ON AGED AMMUNITION REVIEWED

Continued

was stored in an unheated, frame structure where ambient temperatures ranged between -15 degrees F. to 80 degrees F. with no measures to control air humidity. This is not an isolated case. I have used other factory and handloaded ammunition of similar age under the same conditions with no apparent changes in performance.

I recently took the time to test some of the former Herter's 6mm Remington International Match Grade ammo that had reached the ripe old age of 30 at the time of my evaluation. One could be led to believe that was some of the finest ammunition ever assembled because it said so right on the box: Loaded to 1/20 grain powder variation, finest 100 grain Banana Peel bullets made in Sweden with Swedish brass, and the world's finest powder made in Scotland... this

had to be good stuff. Anyway, to further my tests on aged ammunition I decided to shoot three five-shot groups of this ancient ammo through my 6mm 40X Remington heavy barrel target rifle of known accuracy. I had no idea how this ammunition would have performed the day it was loaded, but I must confess, it performed very respectably in April of 1995 long after Herter's Inc. — as a company — decided to call it quits. Groups were all under .800 inch at 100 yards with the smallest at .750 MOA. When it comes to 100 grain factory loads in this cartridge, I've seen much worse.

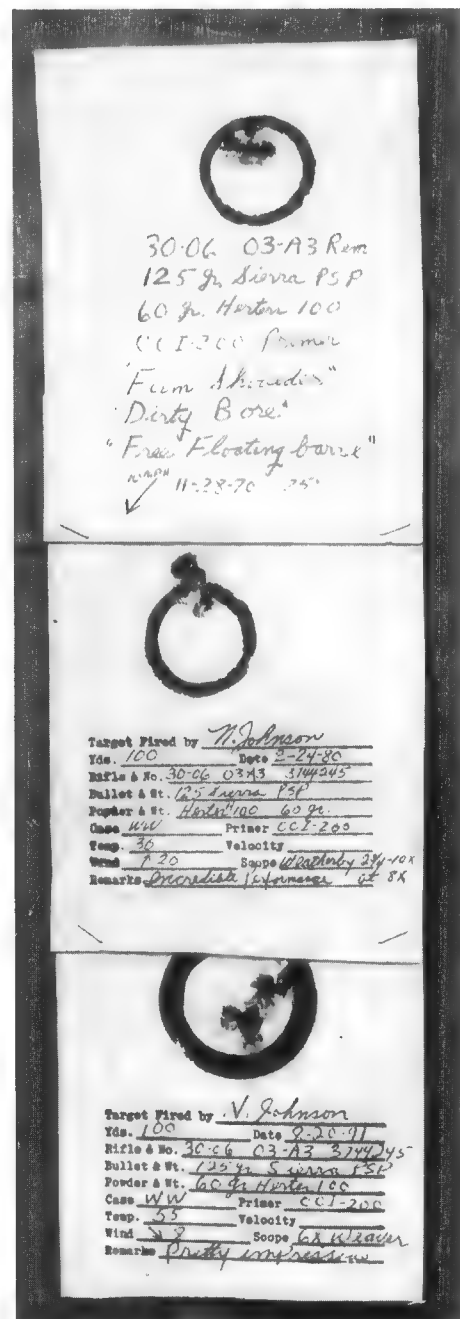
While on Herter's products, I'll devote a few sentences on their "Model Perfect" rifle powders. This product too, came complete with a pretty attractive buyers enticement: "Guaranteed equal or more precision-made and uniform velocities

than any gun powder made." Herter's sent me a batch of their No. 100 powder twenty-six years ago. It is/was made in Scotland and resembles H4895 at a quick glance with a slightly larger grain diameter. The powder is progressively-burning, single-base coated with methyl centralite. Burning rate is quite close to IMR4350 by manual listing. A complete data manual was available with the powder which listed at \$2.25 per pound when comparable brands sold for \$3.00. They had eight powder types at the time (1967) when I received my batch.

To conclude my comments on Herter's powder, I can report with honesty that it performed extremely well back in 1967



6. Groups fired using little known Herter's powder made in Scotland, with 30-06 Sporterized 03-A3 Springfield rifle. Exceptional accuracy was attained at date of loading (11-28-70) and again 10 years later, and finally at 21 years. All groups were under an inch at 100 yards with two groups at half minute-of-angle. Load used was 125 gr. Sierra PSP bullet, 60 gr. Herter's 100 powder, CCI 200 primer and Winchester cases.



7. Enlarged photo of Number 6.



8. Three 100 yard groups measuring an average of .670 MOA, shot with 18 year old handloads. Rifle: Sporterized 03-A3 Springfield with original, free-floated barrel and glass bedded action. Load: 125 gr. Sierra PSP, 60 grains Herter 100 powder and "CCI-250 Magnum primers". (only difference from load used in Photos 6 & 7.)

as it continues to do today. I have included a photo showing a series of three five-shot groups shot over a wide space of time using this powder in my Sporterized Springfield 0A-A3 rifle. Attaining groups of this size with any sporter rifle is indeed rare, say nothing of doing it with a virtually unknown brand of powder that should be on the endangered species list. As I opened a can of the old powder recently, the aroma of ether wafts from the can just like it did 28 years ago.

As I share these experiences with you I make no statements of one type of powder or component being superior to another. My primary objective in connection with these foregoing tests was to determine the effectiveness of aged ammunition, or components that may contribute to the combined performance of ammunition.

As a former U.S. Marine we were told to never question the reliability of the caliber .30 Ball ammunition we would be using in practice or in battle. We were told the ammunition had been subjected to many tests including freezing, exces-

sive heat, under water storage and aging. Come to think of it, I can't recall a single misfire by myself or anyone using that Ball ammo in our old M1 Garand rifles.

Early in my study of ballistics I worked with the late Fred Ness who lived near my home. I can clearly recall his comments regarding Federal primers, of which he was involved in the formative stages of testing and development. He said these primers were repeatedly subjected to extreme tests, including actual baking to the near ignition point, followed by freezing, among other tests, and the brisance of these primers was virtually unaffected.

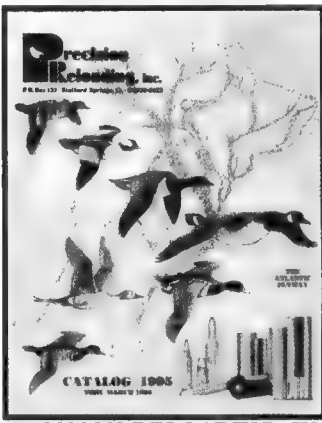
I, too, appreciate the appearance of fresh, new ammunition and handloading components, but beneath the blemished exterior of those aged cartridges and time tested components I have developed an unshaken confidence that each will perform when the time comes to use it.

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CLEANING RIMFIRE BARRELS

by

Milt Cook

International Rimfire 50/50, a .22 rimfire benchrest competition, has just concluded its second year, a year in which over 400 people competed. Some of the questions competitors most frequently ask concern the cleaning of rimfire barrels. Rather than share my considerable knowledge by giving away the cleaning secrets that have consistently put me at the top of this competition, I decided it might be a better idea to ask some of our best shooters from 1994 how they cleaned their barrels. A survey was sent out with the following questions: (1) How and with what do you normally clean the barrel? (2) When the barrel has excessive lead build up, or is excessively dirty, do you clean the barrel differently? (3) How many rounds do you fire before you clean the barrel?

Thanks to the following people for sharing their knowledge with the rest of us and for taking the time to answer our questions.

MIKE NIBLETT..... "I clean my rimfire barrels exactly as I do my centerfire barrels, by first using a wet patch with Shooter's Choice, then brushing the barrel 20 to 30 times with a brush saturated with Shooter's Choice. Next, I use another clean patch, followed by a wet patch or two, then finally two dry patches. If the last patch in normal cleaning shows flecks of lead, I use J.B. bore cleaner on a patch, followed with a dry patch until I can see no more lead on the patch. I usually push a dry patch or two through the barrel after a match. If I see lead, I will clean it, but usually I shoot four or five matches between cleanings.

"I believe the ammo you are shooting has a great deal to do with how often you have to clean. Luckily, I still have a good supply of FIOCCHI Silver Stardust(and who do we have to thank for that?).... and it seems to be very clean compared to the new FIOCCHI and even ELEY Tenex. I have chronographed various makes and lots of ammo. Silver Stardust is the slowest of the various premium ammos that I have shot and this possibly could be one of the reasons it doesn't foul as bad."

STEVE ARNOLD..... "I clean the barrel with patches and PAL oil. When the barrel has excessive lead build up, I use Pro-Shot lead remover, a nylon brush and then PAL oil. The number of rounds I fire before cleaning the barrel depends on

the gun. The Suhl 150, every 500 to 750 rounds. The Anschütz Sporter has never had lead build up.

"I clean the barrel after each match with PAL oil. When the rifle starts to lose accuracy, I try to remove all the lead with Pro-Shot and a nylon brush. Once all the lead is removed, if I don't use PAL oil, I have to shoot about 200 rounds before accuracy returns. With PAL oil, accuracy returns after about 25 rounds."

GRANT KIMBLE..... "I normally clean the barrel of my Remington 40x with Shooter's Choice. I run a dry patch through, followed by a wet patch, then dry patches until clean. To clean when there is excessive lead build up, I follow the above and then run another wet patch through and let it soak for several hours, followed by dry patches until clean. The number of rounds fired before I clean the barrel is approximately 100."

FRED GOULD..... "I clean the barrel of my Remington 541S by running a patch wet with Shooter's Choice bore cleaner through the bore and let it set for four or five minutes. Then I run one more wet patch through, followed by dry patches until the bore is dry. I do not use a bore brush of any kind. This method does not get the barrel as clean as a centerfire barrel. The patches will still come out with a lot of dark color on them, but it seems to help keep the rifle shooting competitively. If the barrel gets excessive lead build up and accuracy falls off, I start by cleaning the barrel as above. I then use J.B. bore cleaner until the barrel is clean and shows no lead build up or fouling. I finish up by cleaning with Shooter's Choice as above. This seems to work, but I then have to shoot two or three hundred rounds before I get the accuracy back. I have no set amount of rounds I shoot before I clean the barrel, but usually average five to seven hundred rounds between cleanings.

"I think this is a subject that needs exploring. I do not know if this is the best way to clean rimfire barrels, but as long as my rifles continue to shoot competitively, this is how I will clean them until there is proof of a better way."

DUANE DANCY..... "When I return home after a match, I run one wet patch (1-1/2" square) of Break-Free Bore Cleaner through the bore of my Suhl 150 using a .17 caliber rod and jag. I follow

this with a second patch of Break-Free and let the rifle sit wet for fifteen minutes. I next run six dry patches through the barrel. I then run a wet patch through the bore using Break-Free CLP and leave it there until I shoot again. Accuracy usually returns after 10 to 15 shots. When the bore is excessively dirty, I run one wet patch (1-3/4" square) of Break-Free through the bore using a .17 caliber rod and jag, scrubbing the chamber and the first 18" of the bore (approximately twenty strokes) and let the rifle set for fifteen minutes. I next run dry patches through the barrel until patches are clean, usually 10 to 20 patches. Accuracy usually returns after 50 to 150 rounds. I only use the second method if usual cleaning does not work, or after firing 1500 to 2000 rounds."

DENNIS BECK..... "My experience with cleaning rimfire barrels has shown me that after cleaning they do not group very well. Therefore, at the beginning of the shooting season I clean my Anschütz 64 very well with a nylon brush, a bore guide and Shooter's Choice solvent. Before shooting for score, it takes around 25 to 45 rounds before the rifle groups again. The rest of the year, the only cleaning I do takes place just before each match. I run a tight dry patch through the bore. This still causes the first 2 or 3 rounds to be inconsistent, but then the rifle will group well after these shots are fired. I do no other cleaning the rest of the season unless groups start to open up, in which case I clean the gun again with the nylon brush and Shooter's Choice."

LEONARD WORTHY, JR..... "When I bought my Anschütz 64, I had a slightly different philosophy than most new gun owners seem to take. For quite a while, I shot with mediocre results. It became obvious that I had to do something to improve my scores. Cleaning the barrel and putting it in a fiberglass stock (it's still in the wood) were just a couple of the options. After much thought, however, I decided that I didn't know enough about wind flags, sorting ammo, and shooting in general, to do anything to the gun. Shortly after that, I tried some FIOCCHI V320. It shot very well. Since then, I have shot well with other ammos. As for cleaning the barrel...I don't. The only thing I have ever put down my barrel is a bullet.

Last time out, I shot a 245-13x with it. I gambled with the wind on five shots and lost. I really believe a more experienced shooter could have shot a 250 with my rifle. In essence, I believe my rifle still surpasses my own capabilities. A dirty barrel may not work best for all 64 owners, but it works for me."

ROBERT CLOPTON..... "To clean the barrel of my Kimber 82, I (Step 1) start with two dry, somewhat loose fitting, patches. Next, I use two patches with Hoppe's # 9. I wait about 2 to 3 minutes, and follow with 3 to 4 tight, dry patches. (Step 2) For the past three months, I have been using a product called Marine PAL on a patch using short, scrubbing strokes, and moving slowly from the chamber out. I follow this with 4 or 5 tight, dry patches. Then (Step 3) I use a few patches soaked in Sports PAL. I leave the Sports PAL in the rifle bore until I'm ready to shoot again. Then, I dry it out with dry patches. (DO NOT SHOOT THE RIFLE WITH THE BORE WET)

"When the barrel has excessive lead build up I add another step to my normal cleaning. In between Steps 1 and 2, I use Remington's Rem Clean on a very tight patch using short scrubbing strokes. I follow this with a dry patch and then repeat the scrubbing. This is the only time I use a bronze bristle brush (rimfire only) with a few passes through. I then continue with Step 2 and 3. I do not fire more than 100 to 200 rounds before cleaning. I like to clean all of my rifles after a match. I do keep track of how many rounds I have fired. My Kimber 82 seems to shoot more consistently after about 20 rounds.

"Throughout this shooting season, I have settled on the above cleaning technique. I use a variation of this technique on all my rifles. Some are easier to clean than others. Some go longer without cleaning. This leads me to believe that not all rifle bores are created equal; Each has a personality of its own."

JIM MACK..... "To clean my Remington 541S, I use one patch saturated with Hoppe's #9 followed by two or three patches saturated with ProShot Lead Remover until the patch comes out clean. I then use one dry patch. When the barrel has excessive lead build up, I do "local area" brushing or lapping at the location of the build up. A couple of years ago I didn't clean the barrel as often as I do now (every 100 to 200 rounds), which I attribute to the ammo that was available then. My perception is that match ammo currently available leaves more powder residue than the same brand manufactured two years ago."

ROY COOPER..... "I always clean a bolt action rifle like my Remington 541S from the breech. I push a dry patch through first, then follow with a patch using Shooter's Choice cleaner. I do this twice and then use two dry patches to remove all of the cleaner. I make sure I always clean the residue from the bolt face each time I clean the rifle. When the rifle starts shooting poorly, or whenever the barrel becomes extremely dirty, I use a brass brush dipped in Shooter's Choice. I push the brush through three or four times, dipping the brush in Shooter's Choice each time. I use several dry patches to remove the cleaner. I usually clean with patches after 30 to 40 rounds. Normally it is not necessary to brush the barrel until after firing 100 rounds or more. These amounts will vary according to the accuracy the rifle maintains.

"The important thing in cleaning, I feel, is to always clean the barrel in the same direction the bullet travels. I never clean from the muzzle or pull a patch back through the barrel. When using a brass brush, I push the brush from the breech through the barrel and then remove the brush before pulling out the cleaning rod. I prefer a steel cleaning rod with a protective coating to help prevent scratching the barrel. I feel that most brands of quality bore cleaners will do the job of cleaning the barrel when used properly."

LARRY HYPES, Sr..... "I start with Hoppe's #9 Benchrest Copper Solvent to clean my Cooper 36. It removes copper, lead, powder, and plastic foulings out of bores. Then I use a teflon coated cleaning rod by Parker. Steel or stainless steel rods will rob barrels of accuracy. I use a bore guide to keep the rod straight in the chamber. When the barrel is excessively dirty, I use one wet patch, one dry patch, and then one wet patch. I let it set for one to three hours, then I take two or three passes with a brass bristle brush. As a rule, I do not use a brush on .22 barrels, just a plastic barb and a cotton patch is enough. I usually shoot 50 to 100 rounds of the same ammo before cleaning with one wet patch and then dry patches until they come out clean. Some rifles you have to clean after 20 rounds, the next rifle you have to clean after 10 rounds. Some rifles are never cleaned and still shoot well....but they're not mine!"

BILL MYERS..... "I clean my .22 match barrels every fifty rounds using Marine PAL on a patch. Every 200 rounds, I use an old 6mm bore brush with #0000 steel wool wrapped around it. I also use Marine PAL on this. The brush and steel wool will remove everything that doesn't

belong there, especially that build up 1/4 inch ahead of the chamber. That's the area everyone seems to have trouble with. Don't be afraid of using the steel wool, as it will not harm the bore.

"When cleaning new barrels, I use the brush and steel wool every fifty rounds, concentrating on the first four inches of the barrel ahead of the chamber. This area will foul more until the barrel smooths out. Then, just clean as you normally would. After cleaning, I put PAL Sports in the bore and leave it there until I go to shoot. I remove it with a dry patch before shooting."

GERRY GRESOCK..... "I have used three methods in cleaning my Dakota sporter and all have been satisfactory from an accuracy standpoint. As a matter of course, I always use a Delrin rod guide and a Dewey coated rod. I started out using the same method normally used for my centerfires, which is; one fairly tight cotton patch wetted with Shooter's Choice, followed by bronze brushing, then dry patched until no residue shows. Shooter's Choice, of course, was used on the bore brush. By this method, it would take about 10 to 15 rounds before the rifle would settle down and group to full potential. I changed techniques to search for first shot accuracy. This second method did not include wire brushing. One patch through with Shooter's Choice, then a tight patch with Rem Clean to work on whatever was clinging to the bore. A second patch with Rem Clean was run back and forth 10 to 20 times with special attention given to the throat area where most of the lead fouling should occur. I then dried with clean patches. This provided me with grouping ability after only 3 or 4 shots.

"I was perfectly happy with this process until a friend and highly respected shooter suggested I try something new. He gave me a small box containing three types of oil called the PAL oil system from GLO Industries, along with instructions on its use. I tried it and have been using it for two months. This is absolutely, hands down, the easiest method I have ever used to clean rimfire bores. My Dakota now groups immediately after cleaning, with the first shot going into the group as well. To clean, I use only the oil designated as Marine PAL on a not too tight fitting patch and run this completely through the barrel. After letting this stand for about 3 to 5 minutes, a tight fitting patch, again with Marine PAL, is run through. I then follow with a dry patch. That's it! No brushing or scrubbing seems to be necessary.

Continued on next page

CLEANING RIMFIRE BARRELS

Continued

Whether this method will prove useful over time is yet to be proven, but my instincts indicate that it will.

"My Dakota barrel does not show a tendency to "lead-up". But if I know it has digested, say 200 or so rounds without cleaning, I will use my method with Rem-Clean. However, since using Marine PAL as my cleaning agent, the barrel cleans just as easily after 200 rounds as after 10. I abide by no set formula when it comes to number of rounds fired before cleaning. If it is convenient I try to clean after 50 fired rounds. I think the benefit from this is mostly psychological. The important thing for me is to clean thoroughly after I'm through shooting. I've probably never fired more than 350 rounds between cleanings and I've not been able to detect any loss of accuracy or any increase in barrel fouling regardless of number. I treated my barrel diligently when new with Friction-Block. Whether this is a contributing factor in its ability to stay relatively "lead-free" is debatable. I don't think it has hurt."

DENNIS BENNETT..... "I clean my Suhl 150 every 25 to 100 rounds by the following method: (a) Spray G-96 Gun treatment into barrel from chamber end. (b) Use .22 caliber cleaning rod. Push 1-1/4" by 1-1/4" square patch through chamber to muzzle, to clean out powder and G-96. (c) Use .17 caliber cleaning rod. Push rod through chamber to muzzle with patch grabbing jag. Use two 1-1/4" by 1-1/4" patches around jag. Place Marine PAL (purple) onto patch. Pull rod back from muzzle to chamber, slightly scrubbing back and forth about 4" from chamber to chamber opening. (d) Let Marine PAL (purple) penetrate for five minutes or so. (e) Use .22 caliber rod with 1-1/4" by 1-1/4" patch. Push through from chamber to muzzle to clean residue and Marine PAL. This normally takes 3 to 5 patches. (f) Use .17 caliber rod with jag. Push through from chamber to muzzle. Wrap two 1-1/4" by 1-1/4" patches around jag. Place Marine PAL (blue) on patches and pull back through from muzzle to chamber. This lubricates and protects the barrel. (g) Use .22 caliber rod with 1-1/4" by 1-1/4" patch. Push through from chamber end to remove any excess Marine PAL. I find this method to work very well. It only takes about two fouling shots and the gun is back in.

"After 500 rounds, when the fouling

builds up slightly in the throat of the chamber, follow the previous steps (a) and (b). Then use a .22 caliber rod with brass brush. Push through from chamber to muzzle. Place Pro Shot solvent onto brush and pull back through.

"This is my procedure on cleaning all my rimfires. I have found this works best for me. Now you are ready to go out and shoot a 250.....if you can read the wind and hold the gun. Apparently I can't do either one!"

HERMAN WRIGHT..... "I use Shooter's Choice, a .17 caliber rod and large patches. I do not use a brush. Since I shoot mostly Eley Tenex, I don't get too much lead build up, but when I do, I use Rem Clean. I clean my barrel after going to the range, whether for practice or a match. My third round after cleaning is dead on."

BILLY RUSSELL..... "I never use a brush. I use a wet patch with Shooter's Choice followed by two dry patches, using a back and forth scrubbing motion. This is done four or five times. I fire approximately 800 rounds between cleanings. It may be wrong, but I stop my cleaning process while I am still getting a small amount of black on the patches, but no small lead flakes. In my opinion, the black is wax and a little powder residue. If you take it all out, the gun won't shoot good until it is waxed up again...so why bother getting rid of all the lead and excessive wax?"

DAVE POLOVINA..... "To clean my Winchester 52E, I use only patches and coated rods that I wipe clean after every patch. My solvents are mixed. I use Miltex-1 Synthetic Based Metal Conditioner, Marine PAL, and Firepower FP-10 metal treatment. When the barrel is excessively dirty, I will let the Marine PAL sit overnight in the barrel. The next morning, I will use the tightest patch I can get through the barrel. If after several patches the barrel isn't clean, I will do it again using Firepower FP-10. I let it sit for 30 minutes and repeat until clean. The number of rounds I fire before cleaning depends on the rifle. If it's shooting consistently and predictably...why mess with a good thing! If it's changing impact or I switch brands of ammo, I clean it."

ED HARSHMAN..... "To clean my Remington 541S, I use a stainless rod, Shooter's Choice bore cleaner with a brass brush and patches until clean. Then I finish with a patch sprayed with WD-40 and put it lightly in the bore. I do this after every match."

JAMES CANNINGTON..... "After finishing a match or after 100 rounds, I clean my Suhl 150 with two dry patches through the bore and nothing else. If the

barrel has excessive lead build up or after firing 500 to 600 rounds, I use patches wet with Johnson Engine Tuner. I let soak for ten or fifteen minutes and dry with as many patches as necessary to insure that the bore is dry. I follow up with a wet patch of Hoppes #9. I leave the bore wet with the Hoppes #9 until the next match and then dry the bore prior to firing.

"Due to the confusion and lack of a clear consensus on the best method of cleaning a rimfire barrel, I have been most reluctant to do anything to my barrel. I am new to the rimfire game, having shot high power competition for forty years. I thoroughly scrubbed my high power barrel after each trip to the range, and now I find it difficult to leave my rimfire barrel without a complete cleaning out. My rifle seems to require 30 to 40 rounds through the bore after a complete cleaning before it settles down and groups again. I'm currently using Russian Olympic, which has heavy lubrication. The dry patch comes out very black and greasy, but the bore looks bright and clean. I never, ever, use a brush in the bore."

JAMES WARREN..... "I always clean my Remington 541T from the chamber using a Dewey (coated) rod. I have modified my Ruger 10/22 so I can clean it from the rear, also. My latest method of cleaning is: (1) Push a couple of patches soaked in Shooter's Choice Black Powder Gell through the bore to remove most of the loose powder fouling. (2) Run a bronze brush through a dozen times or so. Apply Break Free CLP about every fourth pass. (3) Push several patches soaked in Break Free CLP through, allowing it to sit for a couple minutes between patches. (4) If necessary, repeat steps 2 and 3. I usually do not have to, though. (5) When the patches are coming out clean, I run ONE dry patch through and call it good. I do not attempt to completely remove the CLP. (6) I do not oil the barrel between shoots. It is pretty dry here in Utah and the Break Free seems to lube it enough. If I were going to leave it for several months, then I would run a patch of oil down the bore before storing it. While this seems to work, I am planning to get some of the PAL products which were reviewed in PRECISION SHOOTING a couple months back and give them a try.

"If sand or dirt has gotten in the bore, I will use extra Black Powder Gell on VERY LOOSE patches to get it all out before starting a normal cleaning routine. Other than that, I do not change my routine very much. I don't clean after a specific

number of rounds. I usually clean about twice a year. If the bore gets dirt or sand in it, I will clean as soon as possible, but this is pretty rare. (Twice a year usually means around 1000 rounds through my Remington or Suhl, several times that in the 10/22. After cleaning, I like to fire a box of ammo before shooting a match. The accuracy usually settles down after 15 to 20 rounds.

"I feel that peak accuracy comes along after 50 to 100 rounds and lasts for several hundred rounds. After 1000 rounds, I sometimes notice accuracy dropping off, but it takes good shooting conditions to tell when this is happening. It would be interesting to have access to an indoor range and do some serious testing along these lines, but outdoors, I'm not good enough to detect much difference after the first 50 shots. If it were not for the re-break-in that my guns seem to need, I would clean after each match. I'm not yet convinced that it would help, but since I do so with my center fires, I'd probably do it with the rimfires, too.

"I have been shooting Fiocchi V320 lately. Many people feel that you need to clean more often with Fiocchi ammo, but I have not noticed this to be the case yet. Before the Fiocchi, I used mainly Eley BR Gold. The BR Gold is very good ammo, but the Fiocchi is pretty close and with my wife, son, and I all shooting, it saves me big bucks to go with the Fiocchi. If I'm doing serious ammo testing, I will clean the barrel before each brand."

IRWIN ROWE..... "To clean my Anschutz 64, I use soft flannel patches on a rod, occasionally using a nylon brush on the rod. The solvent I use is Qwik Silver Powertune, which seems to work well. If leading is extremely bad, I give it the Mercury (Hg) treatment. I fill the bore with Hg, plug the barrel and let stand for 24 hours. Then drain and wipe clean. I fire 250 to 300 rounds before cleaning."

TOM DOUGLAS..... "To clean my Time Precision, I (1) Use .22 caliber bronze brush soaked with Shooter's Choice. Soak five minutes. (2) Use three cloth patches soaked with Shooter's Choice. Soak five minutes. (3) Use four dry patches. Check for any signs of fouling. If any fouling, go to Step 1 again. (4) When clean and dry, use one patch soaked with E7OX. Soak five minutes. (5) Use one dry patch. (6) Shoot the sucker.

"As far as the Time Precision barrel is concerned, it has not had any tendency to foul excessively. In other guns, I have had success using the RCBS Foul Out unit in combination with my standard cleaning procedure. This has always

been successful. I clean after approximately 100 rounds and after every match. I believe the E7OX treatment has been the single factor in removing the tendency to lead fouling. I have been using this synthetic "snake oil" for several years and have been quite satisfied with the product."

JIMMY LOVE..... "For regular cleaning, I use Hoppe's #9 solvent with a plastic bristle brush and a patch. Put Hoppe's on a .22 patch, then put the patch on a .22 plastic brush. Run the brush through the barrel with a patch on the brush. Remove the patch from the brush at the muzzle. Pull the brush back through the barrel. Repeat 3 to 5 times. Run dry patches through the barrel 3 to 5 times. When the barrel is excessively dirty, I use a bronze .22 brush and J.B bore cleaner. After the lead is removed, I repeat the steps for regular cleaning. Usually my rifle starts falling off between 300 to 400 rounds. I do not clean it until my score starts dropping."

GAIL SHUTT..... "To clean my Remington 541T, I push tightly fitting cotton patches, wet with Marvel Mystery Oil, through an out the muzzle - never pulling them back through the barrel. Why this works is a real mystery! When the patches come out with no discolorations, I dry the bore with one or two patches - again pushed through. A quality barrel that has been properly conditioned rarely has excessive lead build up. However, should some leading refuse to budge using the above cleaning regime, I would use a non-metallic bristle brush and Hoppe's to break it loose, followed by the Mystery oil and dry-out. I clean the barrel every 50 to 100 rounds or after a match." (Gail added that Dave Reeder, Rangemaster at the Desert Sportsman's Rifle and Pistol Club deserves recognition for the his tireless efforts in putting on a class act at the matches out there in Las Vegas. A fellow from Arizona who attended the Southwest Regionals called me to express the same sentiments....I want to thank Dave and the guys at the Desert Sportsman's Club for helping to make IR 50/50 competition enjoyable for the shooters.)

BOB MILLER..... "I clean my Anschutz 54 by pushing a dry patch through the bore to remove loose fouling. Next, I insert a soda straw in the chamber. With the bore tilted down, I pour Hoppe's or Shooter's Choice down the bore. After leaving the solvent in for a couple minutes, I dry patch the solvent out. When the barrel has excessive lead build up, I will use Gold Medallion or Rem Clean on a patch. I take five or six strokes through

the bore, and then follow up with my normal cleaning method. I do not use a brush. I usually clean after a day's shooting - about 100 to 200 rounds. If I have been testing different ammos, I will clean sooner using the Gold Medallion.

"In the past, I have used rifles and never cleaned the bores, since I was not shooting competitively. I really don't know how much difference cleaning has made. I do know that by cleaning my rifles, they do keep shooting. I don't see how you could hurt a good rifle by cleaning it, if done the right way. By using the soda straw and a small bottle of solvent, like that which Shooter's Choice comes in, I can get plenty of solvent down the bore without getting the solvent all over the rifle and in the action."

DENNY ANTONIOUS..... "I never use brushes to clean my rimfire barrels. I use a Hoppe's or Shooter's Choice soaked patch with Flitz to clean the first 1/2" of the barrel, using 60 to 100 short, easy, strokes. Using this method, I have never had a lead build up problem. I clean the barrels every 30 to 50 rounds. The barrels respond within five rounds to grouping. With ideal, no wind conditions they will group to .200 -.290."

.....In conclusion, I want to thank everyone again for responding to the survey. As you can tell, there are different methods being used to clean rimfire barrels. If you're lucky, you own the .22 that keeps on shooting no matter what you do. But there is one more person I have to add to this list. She won the 2-Gun Aggregate at the West Virginia State Championship last year, and insisted on sharing her expertise about cleaning rimfire barrels:

HELEN COOK..... "I normally clean the barrel by handing the rifle to Milt and yelling at him to do something because the gun won't shoot. When the gun is shooting good, I dare him to touch it. This winter, Inez McCaughan and I found a secret ingredient from our kitchens to put down the barrels. See if we share this method with the guys."

.....Hey, I had to include her in this survey. She has me over a barrel since she is the editor, typist, photocopier operator, envelope addresser, stapler operator, and stamper for 50/50 NEWS. I'm in charge of the important stuff.....testing rifles and ammunition at the range. But just wait until we go down to Roanoke to the Nationals this year. The ride home should be nice and quiet. I've found a Winchester 52, an Anschutz 54, and that new Sako Finnfire sounds promising.....



BULLET YAW

by
Merrill Martin



Dear Dave:

Our topic for today is bullet "yaw," a very insidious thief of long range accuracy. Like a disease, you might have it and not know it.

Just thought of a good definition for accuracy. What are the **three** most important things in real estate? Location - Location - Location. What are the three most important things in precision shooting — not group size, but bullet location, bullet location, bullet location. That is what wins score matches and hits varmints, nothing worse than a very tight group in the wrong place.

Back to yaw. A good, simple definition would be lack of traveling point forward in the most streamlined fashion. After spending a premium on VLD (very low drag) bullets, it's very depressing to have their benefit cancelled by side slipping to the target.

Am I talking something mythical that you can't define or put your finger on? No way. Like any disease, it's a little tough to accurately diagnose and expensive to pinpoint and measure, but definitely possible to do.

I had a long chat with Dr. Ken Oehler, who filled me in with the accurate Measurement of Ballistic Coefficient (drag measurement). It boils down to measuring the time of flight of bullet from gun to target. If drag increases, time increases. If yaw develops, time increases.

For those readers that have the equipment, time and wherewithal, my yaw exercise will be most rewarding to all concerned, especially long range shooters.

Why my sudden concern? I've been staring at fired targets for years, but my eyes and brain had not been registering what they saw. Some of my bullet holes were not printing perfectly symmetric. Hitting the bull, yes, but the holes just didn't look correct. Dr. Mann has several chapters on how holes should and should not print properly on the paper. The sharp pointed spitzer shapes at medium velocity usually leave a hole in the target paper that can tell a very interesting story. Very high velocity varmint loads unfortunately at close range cut clean sharp hole losing the evidence of where the sharp nose first broke paper. If the bullet nose was to one side, the nose hole will not be concentric with the outside of the main hole as per illustration. For some strange reason, this usually doesn't affect accuracy at close range. A bullet that should be very stable and sometimes prints very offset holes is the 168 Sierra match.

At long ranges, this yaw can increase drag and reduce wind bucking ability. How much in real figures is where the rest of the P.S. staff comes in. How can we induce yaw at will? Very simple, my dear Watson. This was pure serendipity

— With Creighton Audette's case indexing idea of marking the location of the thin side and then always loading the case the same way, I lucked into something. Last match, as I tried locating the index at different positions, I noticed on the target the bullet tip went from dead center to one side, indicating a yawed condition as it passed through the paper. More amazing was that all the bullet tips from one certain index position were center, and another index position off to one side — the same side!! What a powerful research tool, being able to dial in or out the yaw at will.

I don't have the instruments or time to take the down range measurements of the velocity variations, but according to Dr. Oehler, the effect should be substantial and at long range, more so.

Consider what this means — an explanation of these mysterious vertical variations at long range, wind drift where you shouldn't have had any! Yet, the muzzle chronograph readings could have been nearly perfect! The goings-on between barrel and target are forever a mystery.

One weak point keeps coming back to the cartridge case where we **can do** something about it.

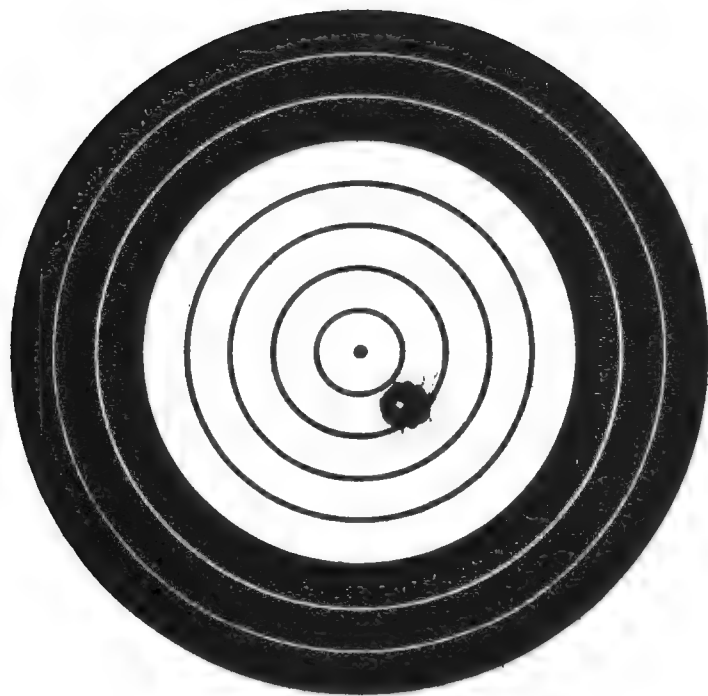
Dave, since we are talking accuracy, I've just got to include this last "improvement" (?) I made to my rifles.

Yesterday, at the 100 yard range, I was working up loads in my 223 & 22/250 varmint rifles (a new shooting sport for me) and had a glorious start with the first few targets in the low .3's. Then, things started to come unglued! Further loads just spread beyond an inch or more. Back to my first control loads and they were all over the place. We sort of crawled back home to cogitate on what happened, look for loose screws, fouled bores, etc. Everything looked in order. Middle of the night, it hit me. My wife was ready to.

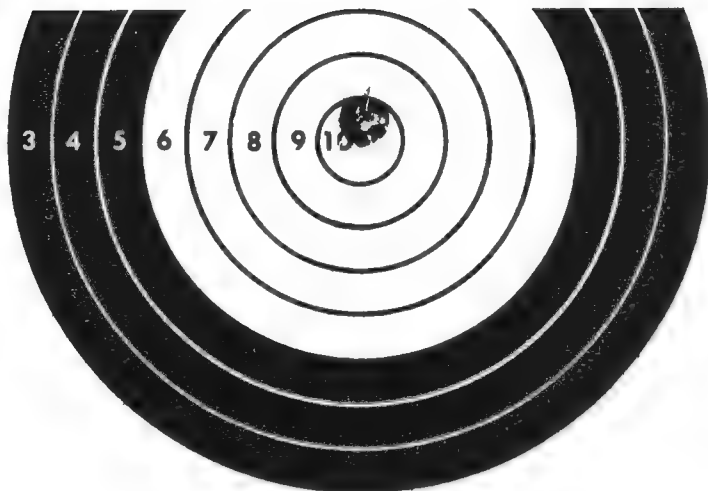
As these varmint rifles will be shot rapidly and can get quite hot, heat mirage from the barrel can obliterate scope definition unless you're using a long scope sun shade or a mirage band over the barrel. Since I expected to be traveling far and going out in the field, I felt the long scope tube would be cumbersome, so yesterday I went to the mirage bands. I first used mirage bands on my long range iron sight rifles in the 1950's with great success, stretching the bands tight between the front sight and rear scope blocks.

Since I had a scope on these varmint rifles and no front sight to hook into, I got very clever and used Velcro® at each

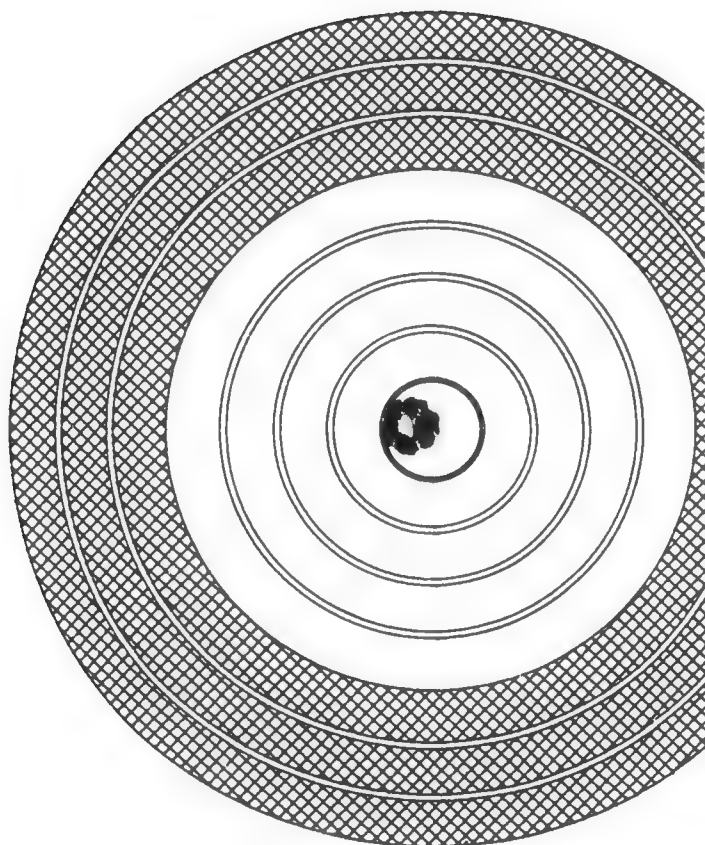
Continued on page 36



Yaw ↗



Bad yaw ↘



Split Yaw ↗

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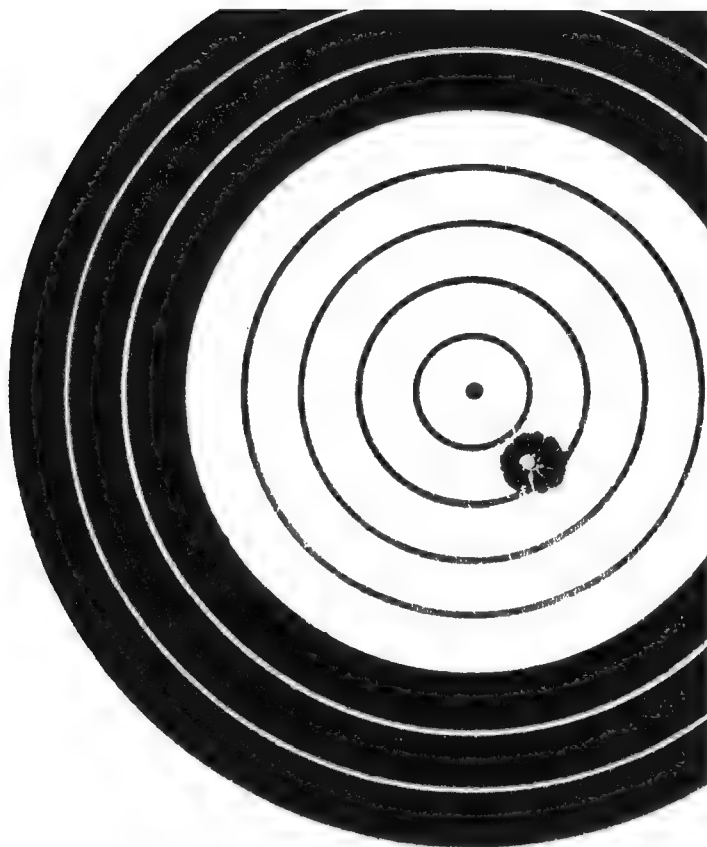
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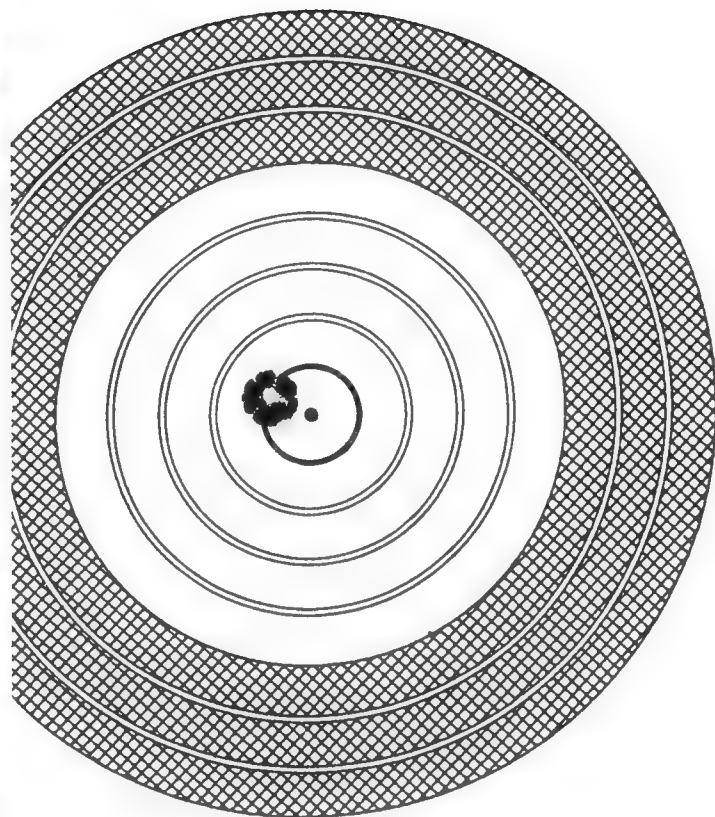
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2X Blow up Bad yaw ↖



yaw ↗

BULLET YAW

Continued

end of the barrel. A small 1" square of self-sticking black Velcro® at the muzzle and another just in front of the scope. It looked and worked great.

Yesterday was a cool overcast day, so we started out leaving the bands off — rifles shooting great. As the barrels started getting hot and the heat mirage causing the scope image to deteriorate, I stretched on the bands. After that, things went to hell.

Could the black patches on top of the barrel prevent the heat radiation and create a hot spot deflecting the barrel? We suspect so, and will know next time out to the range, **less** the Velcro®.

But, of corroborating interest — when cleaning the rifle bores which were not copper-fouled, we carefully borescoped the barrel, end to end, looking for something — we found it. Directly under where the Velcro® patches were stuck on were streaks of copper on the upper side — not bad fouling, but an indication of extra pressure against that side of the barrel, just like when we had a bent or curved

muzzle section and had to cut it off. A hot spot on one side of a piece of steel will certainly cause it to deflect away from that area as the hot spot expands the metal.

The previous week I had used sun shades on the scope with no problems, hot or cold. Boy, do we learn the hard way.

I just got through talking with Mike Shepard, another shooter experimenter and mentioned the suspected Velcro® episode and did his eyebrows suddenly go up plus a few unprintable words. Seems he was working with one of his very reliable varmint rifles and had Velcro®-attached a thermocouple for heat measurement and when the barrel got fairly hot, his groups went to hell. That gun had never done this before either. This information should be of great interest to lots of shooters. Who would ever have thought something so easy and simple could bite back?

Yours truly,
Merrill D. Martin © 1995

(ADDENDUM: a few paragraphs further on the same topic, pulled from a recent Merrill Martin letter, addressed to a PS reader, dealing with this very matter. I thought that they fit well here. Editor.)

For Precision Shooting, things attached to the front end (also rear) of the barrel have to be looked at very carefully and understood how they affect things as the barrel gets hot. Front mounting blocks for iron sights do create a little stress from the holding screws. I would be more concerned by **clamping** anything on the barrel as this not only could, but will, minutely collapse or close the bore under the clamp.

A stress-free solution would be that wonderful stuff called Loctite with the front band a slip-fit and the Loctite between. Use the high strength stuff and follow directions. Don't use dissimilar metals, like an aluminum band on a steel barrel as that would guarantee trouble. Your barrel temperature range would not effect the Loctite and going to 500°F you can easily remove the band.



GUNSMITHING VIDEOS

Steve Acker is a gunsmith and machinist who writes a column ("The Gunsmith Machinist") for *Projects in Metal* magazine, and who has had a number of other machining articles published in *The Home Shop Machinist* over the past several years. His work as a gunsmith is superb-meticulous in its detail. Steve has produced three excellent videotapes you will want in your library.



Steve shares with you his shop techniques for both basic and advanced rifle work on the Remington 700 bolt action rifle. He shows you how he corrects some common rifle problems using hand tools or, for the more ambitious gunsmith, using machine tools to correct problems of excess headspace. For the advanced gunsmith/machinist, Steve demonstrates how he builds a custom hunting rifle barreled action. Tools, techniques, and parts are all described. You will see bench rest style action truing, recutting of receiver threads in the lathe using a single point cutting tool, precision fitting of the bolt to the receiver and the barrel, match grade barrel threading and chambering, and cutting match grade muzzle crowns in this step-by-step presentation.

If you've ever hoped to do more work on your own rifle, and achieve greater control over your shooting skills, these videos are the perfect first step for you.

Tape 1: Bedding, Scoping and Crowning the Remington 700

In this tape, Steve shows you how to have a rifle that is easier to shoot accurately, with little or no shift in zero, using only hand tools. Bedding techniques are demonstrated on three styles of stock. His methods for mounting and lapping in a scope, and his crowning process will give you new hope for improved shooting. (2 hours).

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Tape 2: Correcting Bolt Lug Engagement and Excess Headspace

Here, Steve shows you how a gunsmith can rework the Remington 700 bolt action rifle to make it more accurate, using basic tooling and setups in the lathe and on the workbench. The work is done on a factory varmint rifle that is not as accurate as it should be, and which has long headspace. He also improves the bolt contact and the front receiver ring contact. (1 hour, 35 minutes)

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Tape 3: Truing the Action and Installing a New Barrel

Steve goes to work on the lathe and mill to make an accurate custom bolt action hunting rifle. The result is a fairly light, accurate, stable, and reliable firearm. He shows you his own techniques for truing the bolt face and lugs, threading and crowning a new barrel, recutting the receiver threads, machining the recoil lug, and much more. (2 hours, 30 minutes)

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"CARBON ONE"

An exciting new concept in riflery

by

C.W. "Chuck" Cornett

With the dates of Prairie Dog 'Conference' getting closer all the time, I received a call in June, 1995, from Dick Lyman at Christensen Arms in Fayette, Utah, telling me about revolutionary new rifles they had developed and asking that representatives be able to come to the 'conference' and bring a few rifles for the writers to shoot and evaluate. Even though the registration was closed, I invited them to come and mill around with writers and shooters during the three evenings of fun and fellowship. When I arrived in Malta, Montana, on Sunday, July 9, two identical Carbon One rifles in caliber .22-250 Remington were waiting for me at West Side Sporting Goods. One was fitted with a 6-24 variable Bausch and Lomb scope and the other with a 6-24 variable Pentax scope. This convinced me that the men from Fayette really knew what they were doing.

Still, I didn't know what I had. The action was a 700 Remington (blueprinted as it later turned out) with a MPI stock and 2 oz. Shilen trigger. There appeared to be some sort of material wrapped around a very small diameter stainless steel barrel. The exterior of the barrel surface appeared to have a small diamond pattern with clear coat applied. The outside diameter of the barrel was in the configuration of a heavy varmint which would normally weigh at least ten pounds but this one came to only 6 1/2 pounds! I had with me a Savage .22-250 112 BV SS fluted model rifle with a laminated wood stock and mounted with a Bausch and Lomb 6-24 variable scope. Like every Savage I've ever owned, it was extremely accurate right out of the box and shot in the 3's and 4's using a load of Hodgdon Varget powder and Berger 52 grain benchrest bullets....but it weighed 13 1/2 pounds with scope.

I took the Carbon One into the field with me several days before the 'conference' began. There is no formal rifle range in the area so I sighted it in on "prairie dog rocks" using factory Winchester .22-250 ammo that Mike Jordon furnished for the event. I was pleased to find it would shoot with



"minute of prairie dog" accuracy using this ammo. I was able to call my shots out to 400 yards which I consider to be about the maximum effective range for prairie dogs. Beyond that it becomes "artillery fire" and, oh, yes, you'll hit them beyond that but with any wind or mirage you'll probably miss more than you hit trying to get there.

Christensen Arms President Roland Christensen and Gunsmith Evan Mitchell arrived in Malta on Thursday and gave me complete information about the rifle and history of the company. They brought three more of their Carbon One models for writers to evaluate and there was great interest expressed in them.

Back in Fresno I removed the Bausch and Lomb scope from the Carbon One and weighed the rifle at 6 lbs. 9 oz. and with the scope the scale showed 8 lbs. 9 oz., very light for a .22-250 heavy varmint barreled rifle. A story donated by Gun World Editor Steve Comus to my Prairie Dog Digest, was waiting for me as well. He noted that he had used a Browning .223 caliber Low Wall at the 'conference' and found that this very light rifle possessed outstanding accuracy and, in his story, he emphasized what a pleasure it was to handle it in the 100 degree prairie heat. An idea began taking shape in what ever it is that holds my ears apart. I thought, "Why not?"

I called Steve to discuss with him the notion of making a super light bolt action varmint rifle. I wondered if the Carbon One project could not be taken a step further by reducing the weight even more and Steve encouraged me to investigate the idea. I called Evan Mitchell at Christensen Arms who was cool at first, but then got fired up with the concept. I shot the Carbon One (Serial Number 2) and was getting five shot groups in the 7's and 8's with factory ammo. I tried loads suggested by Evan Mitchell using H-4895 and H-380 powder with 52 grain Berger bullets but still was not satisfied with the results. Evan cuts an extremely tight chamber and full length sizing of cases fired in other rifles would not reduce them enough to fit Carbon One. I ran cases through a small base .308 die which did not improve things. Even after I fired factory ammo and fed the fired brass back through the chamber, the bolt hesitated and required an extra tug to extract the case. When this fired brass was full length sized, however, it fit perfectly.

Onward to Salt Lake City where I rented a car and drove to Fayette, Utah, to see the Carbon One rifle being made. By the time I arrived, Evan already had the barrel for the Carbon Light rifle turned and installed on a Remington 700 action nearly ready for the carbon application. He had calculated that the completed rifle, in .22-250 caliber, would weigh in at approximately five pounds! He examined the Carbon One, Serial number Two and could find no defect but gave me Serial Number One that was fitted with a 6-24 Burris scope to bring back to California.

Meanwhile, Evan started with a Shilen barrel weighing 9 pounds and *turned 8 pounds off the blank*. The remaining barrel looked like a coat-hanger by contrast but the application of the ultra light-weight carbon brought the outside diameter to the appearance of a heavy varmint barrel configuration. (Since they were ordering Shilen barrels in lots of fifty, I realized that they were serious about this business!).

President Roland showed the origin of the graphite, used in the manufacture of

the barrel, which is a very light material, flat and looking very much like a black shoe lace. The end was splayed, showing it was made of 6,000 extremely fine strands of carbon fiber. This graphite product is custom made for Christensen Arms into .006 thickness strands impregnated with liquid epoxy resin, and it is these that are applied to the barrel to form the outside diameter of a predetermined size. There are two approaches to this application:

(1) Use a mandrel to wrap the strands, criss-cross fashion for added strength and affix the "sleeve" to the barrel or, more likely, (2) wrap the graphite directly onto the rifle barrel, with a sort of "shrink-wrap" result. The barrel is then put into an oven to harden after which it is ground to shape. An exterior woven cloth is sometimes added to give it a decorative appearance and a finish clear coat applied.

Evan, in one torture-test procedure, put a Carbon One .22-250 in a vise and fired it 48 times as fast as he could load and pull the trigger. He reports that he used thermocouples to measure the outside surface of the stainless steel barrel at 280 degrees Fahrenheit where it made contact with the graphite but reported

that the test did not seem to affect the rifle's accuracy afterwards.

Evan had also built a Carbon Cannon rifle in caliber 7 STW which he equipped with a muzzle brake and which he intended to take on a bear hunt the following week.

The Christensen Arms machine shop is well equipped to meet all the demands of manufacturing procedures necessitated by the "Flex-Foot" they manufacture. This artificial foot is a work of art that permits an amputee to compete as a runner, mountain climber and to participate in a wide variety of strenuous activities not possible by the use of many other appliances. The facility has the capacity to mold parts and subject them to pressures of 20,000 pounds at 270 degrees Fahrenheit for 15 minutes to harden the graphite material.

Roland Christensen, Ph.D., was born in Fayette, Utah, youngest of five children, and is currently the Mayor. At age five he began shooting a Benjamin Air Rifle and, as an officer in the U. S. Army, entered a quick shoot contest with an air rifle starting with a plate thrown into the air and finally he won by shooting an aspirin out of the air! Roland hunted birds and rabbits as a boy and worked the fields to

earn enough to buy his first .410 bolt action shotgun.

When he reached age 16 he expanded his interests to math, mechanics, electric motors, go-carts, girls and a Winchester caliber .300 Savage lever action rifle, not necessarily in that order. After graduating from high school he entered the Mechanical Engineering School at Brigham Young University, married Julia, and transferred to the Mechanical Engineering School at the University of Utah finally graduating with honors with a Doctorate of Science in Mechanical Engineering. After serving in the U. S. Army he worked as a rocket scientist for Hercules, Inc. This effort included design and structural analysis on the filament wound, kevlar/epoxy structural composite Trydent Rocket Motor Case, graphite/epoxy thrust nozzles and the rocket motor's solid propellant. After five years he left Hercules and spent two years with Fiber Science after which he affiliated with Fibertek, also involved in the manufacture of graphite epoxy based items.

It was at Fibertek that Roland met Evan Mitchell and, after being involved in individual businesses, by 1990 they both

Continued on next page

Questions anyone?





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"CARBON ONE"

Continued

moved to Roland's newly formed Applied Composite Technology company that developed Flex-foot, orthotic halos, cross-bow limbs for the archery industry as well as helicopter drive shafts.

His love of big game trophy hunting of mule deer, Rocky Mountain elk, caribou and black bear led him to work with Evan to design and build the Carbon series of rifles.

Master Gunsmith Evan Mitchell, born in Utah Valley, also worked the fields and fired his first shot with a Red Ryder Daisy air rifle followed by a single shot Remington .22 rimfire. At age 14 he bagged a four point mule deer with a Mauser Model 98 in 30-06 caliber. His experience includes elk and bear and hunting with a bow and arrow. Evan received an Associate of Science Certificate from Utah Valley Community college and went to work for Clark Engineering. After two years he went into the U. S. Army corps of Engineers and received a certificate as the best machinist at Fort Carlson. After discharge he returned to Clark Engineering where he was foreman over fifty machinists and, after seven years, left to advance his career at Fibertek. He and Dr. Christensen left Fibertek after several years to enter their own businesses and, in 1990, Evan joined Roland at Applied Composite Technology.

Before long the first Carbon One rifle appeared in .22-250 along with the 30-06 Carbon King and then the Carbon Cannon in caliber 7 mm STW. While

most of the rifles are built on the Remington 700 action, Christensen Arms can use any action or barrel on a special order basis.

Back in Fresno I weighed the Carbon Light rifle at 5 lbs. 4 oz. with magazine box, spring and follower intact. The MPI stock weighed 1 lb. 1 oz. with the magazine box in place. I called Mark Brown at Brown Precision and Dick Davis at McMillan Gunstocks to see if they could provide a lighter stock, I was told "No way!"

I mounted a 36X Weaver benchrest scope on the Carbon Light using Burris Pos-Align rings. The total weight was 8 lbs., 7 oz. Since I try to hit what I'm aiming at, I never use the magazine on a rifle so I removed the magazine and follower, installed a Davidson block that I had ordered from Russ Haydon Shooter's Supply, and reduced the total weight to just 8 lbs. 5 oz. The total for the rifle alone was just a hair over 5 lbs.

Next I headed for the range to begin testing the Carbon One, Serial Number One, in .22-250 which was fitted with a Burris 6-24 variable scope and was surprised at the accuracy I got when reloading 52 grain Berger bullets at full throttle. Generally, greater accuracy may be expected to improve when the velocity is slowed a bit but, as usual, I take them to the "edge" with maximum loads. The wind was gusting from 8 to 9 mph in 95 degree heat. The best 100 yard group was with Hodgdon H 4895 powder using Remington 9 1/2 primers that measured

.430 and another using W760 at .470.

Carbon Lite, the first time around, produced a .520 group with W760 powder, Remington 9 1/2 primers with 52 grain Berger bullets seated .010 off the lands. It remains to be seen what bullets, powder and primers it likes.

All of the above groups were measured with the Neil Jones measuring device and all were five shot groups. Further modification to lighten Carbon Light will proceed with the use of an aluminum alloy bolt shroud and overall weight can be further reduced by replacing the steel rings and bases with an alloy set.

I had worried about recoil from the .22-250 since the stock has a hard rubber butt-pad but it was neither noticeable nor uncomfortable.

Summary; If you want an extremely light, durable, accurate rifle whose heart is a Shilen stainless steel barrel, Carbon Light will fill the ticket. I wouldn't describe it as being designed for the economy minded shooter but it's the same old story again; If you want nice fresh oats to feed your faithful horse, you'll have to pay a fair price. Once they've passed through the horse, they're a lot cheaper.

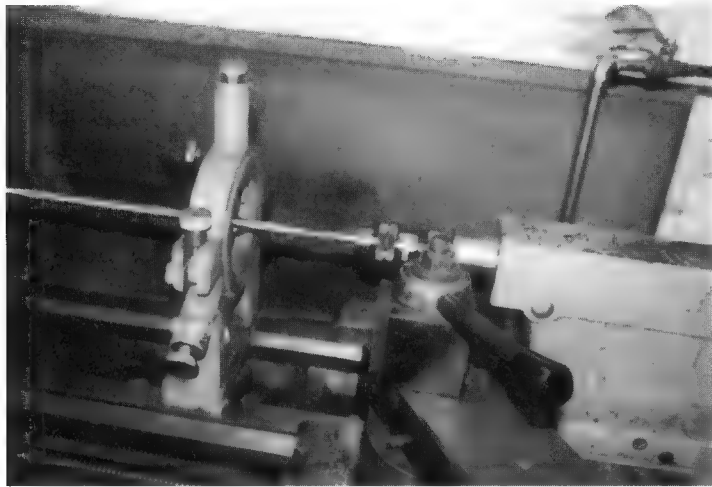
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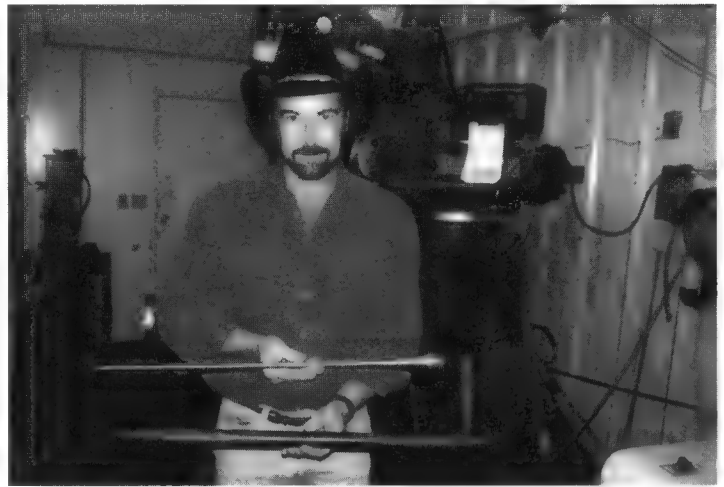
President Roland Christensen with their "Carbon Cannon" model, in 7mm STW chambering. Remington 700 action, Shilen barrel, Burris 2 1/2-10 scope, MPI stock, muzzle brake... ready for graphite application.



Gunsmith Evan Mitchell has taken a 9 pound Shilen barrel, and has just made a 1 pound barrel out of it.



In case you want a closer look at a 1 pound barrel...



Before and after... a Shilen .224 barrel blank (bottom)... and a turned Carbon Light barrel.



Gunsmith Evan Mitchell with a 6 1/2 pound Carbon One .22-250.



Bottom to top: a) 9 pound Shilen barrel blank; b) Barrel turned; c) Barrel fitted to Remington 700 action; d) Finished Carbon One .22-250, MPI stock, 6-24 Bausch & Lomb scope.



Gunsmith Evan Mitchell reading The Good Book. Fellow can't be all bad!



Dogfather, and your humble scribe with the Carbon One .22-250 at the 1995 Prairie Dog Conference. (Editor: Let's talk about your selection of this "humble" word here....)

TROUBLE IN (HIGHPOWER) PARADISE

(Bernie Friesecke)

Have you ever wondered whether a bottleneck cartridge, two thirds full of powder would shoot differently if it had the powder horizontally along the case or stacked in the back? And if it did shoot differently, then how much?

Some years back, in a rather dramatic way, I had to find out the answer to the those questions.

I have been an active competitive shooter most of my life and the incident described here happened in over-the-course Highpower shooting – in particular, rapid fire 300 yards prone. Back in the 1970's, before we went to the decimal target, we had a 12 inch bullseye with a V-ring in the center. Any shot in the black was scored a 5, and nothing was lost. When the decimal target, with an X, 10 and 9 in the black, came out things changed for the worse. I started to get a consistent high 9 in every string. Even when I would shoot more than one 9, that high 9 was always present.

I have always been an excellent 300 yard rapid fire shooter, and this high 9 was beginning to cause me to lose matches and in some cases, entire aggregates. I did a study of my score books for the prior years on the 5V target and discovered that there was almost always a high shot in the group in the 300 yard rapid fire stages. Apparently, this single high shot phenomena had been with me for a considerable period of time. The fact was that on the 5V target this high shot did not cause me to lose any points, and so, did not cause me grief with my scores. All one had to do to shoot a possible of 50 points was to keep all the shots in the black, which I did with fairly consistent regularity; V's were nice, but not necessary.

In the time frame that I was having all these high shot problems I was shooting two different rifles. Both rifles were chambered for the .30-06. The first was a model 70 Winchester target rifle with an Atkinson barrel, and the second was a Springfield with a Douglas barrel and target marksman stock. The barrel fitting was done by my good friend, the legendary Crelghton Audette. Both of these rifles shot .70 inch groups from a bench at 100 yards with good handloads using 168 and 190 grain Sierra Matchkings.



Photo 1. This is a photograph of the original first target fired in the testing. These two groups were fired using the 168 grain Winchester match bullet. This is the standard SR-C target used at 200 yards.

For those of you who must know such things, the twist on both of these barrels was 1 in 10 inches. Both of these rifles shot high 9's in rapid fire prone with frustrating regularity.

The ammunition I was shooting in my two rifles was all handloaded and were of two categories; 200 and 300 yard, and 600 and 1000 yard. The long range 600 and 1000 yard ammo was loaded with 190 Grain Sierra Matchkings, 41.7 grains of 4895 into a variety of G.I. match cases. In both, the primers were Remington 9 1/2.

The question may be asked whether it was my handloading techniques that were at fault. I'm an Aeronautical Engineer and at the time I had 5 years experience in quality control and was a meticulous handloader, I had the latest state of the art loading equipment and was following the latest loading techniques.

Back at the range I embarked on a series of corrective procedures, not my

own, but many helpful ones (and some not so helpful) suggested by friends and other shooters. You all know how shooters are; everyone had a pet theory that I had to try to eliminate those high 9's. I shifted position, tightened the sling, loosened the sling, switched shooting jackets, shooting glasses... nothing worked. One day a shooting buddy and I were at the range, pulling targets for each other, when I got an idea. I asked him to watch each shot go through the target while I shot at 300 yards rapid fire. I fired three strings of ten shots each while my buddy carefully watched the shots going through the target. Know what? Each string was a 99, and each 9 was the first shot of the string. Subsequent testing further confirmed that the high 9 was always the first shot fired. I deliberately fired some ten shot strings, aiming the first shot low, and the shot went in for a ten. I now knew that, for some unexplained reason, the first shot in my rapid fire string was a high shot, BUT WHY?

The very same day I fired those first shots low to get a 10, I also did an experiment. I went over to a 300 yard bench and fired 20 shots slow fire over sand bag rests. Every shot was an X; not one high shot in the whole bunch! Now I was really baffled. I went home that day with a firm resolve not only to define the problem, but, more importantly, to solve it.

The night I got back from the range I went back to my old score books once more and studied them in greater detail. I found that not only did I have this high shot problem at 300 yards, I also had it at 200 yards, both in offhand and rapid fire. I also noticed that when I used G.I. match ammunition or G.I. ball ammunition the high shot problem did not occur. It was becoming distressingly clear that this evidence indicated that there was a strong correlation between the high shots and the short range handloaded ammunition I was using.

The .30-06 short range load of 41.7 grains of 4895, and a 168 grain bullet, with the Remington 9 1/2 primer had an interesting development history. Notice I did not specify the brand of 4895. That's because over a period of time I used DuPont, G.I. surplus, and Hodgdon powders, all with the same result. In addition, I used 168 grain Sierra, Hornady, Winchester bullets, again all with the same results.

The load of 41.7 grains of 4895 may seem strange. I had developed a reduced load for short range shooting because these loads reduce the recoil, which makes shooting more comfortable and allows for a faster recovery during rapid fire shooting. Another advantage of this light load was extended barrel life. It originated from one of the many published reduced loads for the .30-06 in the American Rifleman and the various older loading manuals. One of the best of all those old loads was the famous 300 Meter load of 36.6 grains of HI VEL No. 2 for a published velocity of 2200 FPS. I used that load until HI VEL went off the market. Hey, guys, does this date me, or what?

When HI VEL went off the market I had a considerable quantity of DCM 4895, purchased at 50 cents a pound (I should have bought a ton). I tried a variety of weights of the G.I. 4895 until I had one that shot into the center of the bullseye using the same sight zero I had for the HI VEL; that weight was 41.7 grains. This load was developed using my National Match Springfield with Lyman sights at 200 yards. I shot thousands of those loads over the years. They were extremely accurate and always shot

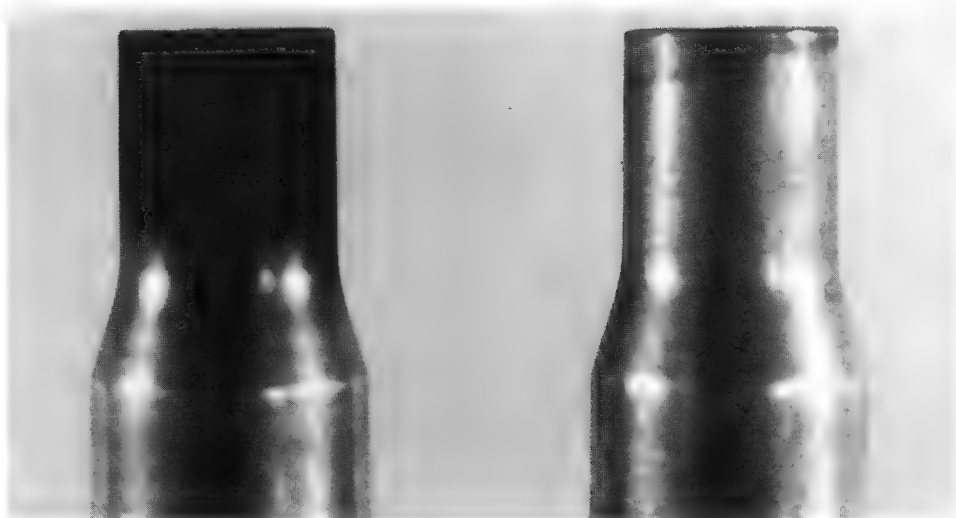


Photo 2. This photo shows the difference of the two different loading techniques. The case neck on the left shows the typical case neck blackening of the normal mid range load. The case neck on the right shows a clean unblackened neck of the vertical loading technique. This case on the left indicates lower pressure than the one on the right.

about .75 inch groups at 100 yards using a variety of rifles with good custom barrels. Of course they also almost drove me nuts by shooting high 9's.

It was now time for some serious experimentation using the various components that I had used over the years. For all of the test ammunition I used LC 62 cases full-length, sized and trimmed, loaded with a single lot of Dupont 4895 and Remington 9 1/2 primers. The charge of 4895 was 41.7 grains, and each charge was weighed. I loaded ten rounds each of three different 168 grain

match bullets; ten were loaded with 168 grain Sierra Matchkings, ten were loaded with 168 grain Hornady match, and ten were loaded with 168 grain Winchester flat base match bullets.

The experimental plan was to shoot at 200 yards from a bench rest using my best over-the-course rifle at the time. This rifle was my Mod. 70 Pre '64 with a 26 inch Atkinson barrel, .307 diameter, with a 1 in 10 inch twist, Vaver rear sight, Freeland front sight, and a Fajen target

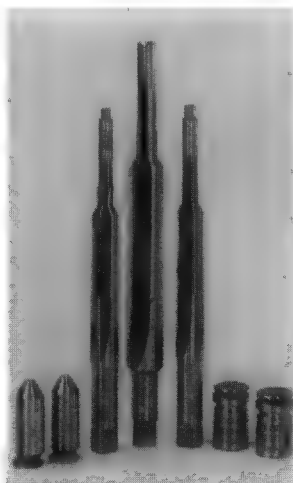
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TROUBLE IN (HIGHPOWER) PARADISE

Continued

stock which I had fitted and customized myself. This rifle was in the exact configuration that I had been using in the matches.

I set up all my gear one sunny afternoon at 200 yards, and the plan was to fire 5 shots, normally loading the cartridges with the rifle horizontal on the rests. I also planned to load 5 shots by holding the rifle vertically, with the muzzle pointed up, then very carefully set the rifle down on the rest so that the powder would remain, as much as possible, at the rear of the case. Why? It occurred to me that when I flopped down into the prone position during the 300 yard rapid fire, I hit the shooting mat with the butt of the rifle, the muzzle pointing up, and that the first shot was fired with the powder in the rear of the case. In all subsequent shots, the cartridge gets slammed forward by the rapid bolt manipulation, and the powder in the remaining nine cartridges is level, or slightly forward, in the case. This, perhaps, might be the problem.

The first group of ten shots was made with the 168 grain flat base Winchester. The first five shots were fired in the normal manner, with the rifle remaining horizontal on the rests. The group was loaded right on the nose, perfect elevation. The second five were loaded into the rifle with the muzzle up, and then carefully lowered onto the sandbags. The first shot of the second group was fired and WOW! The shot was in the white 8 ring at ten o'clock, a full 5 inches above the first group. The remaining four shots all went into the same place, and the group size was nearly double that of the first five shots (Fig. 1). I stared in amazement at this group for some time through my spotting scope; a five inch elevation shift was very difficult to believe! In due course I shot the Sierras and the Hornadys using the same technique, and the very same thing happened, although not as great a difference in groups occurred as with the flat base Winchester. The Sierras were about 4 1/2 inches apart and the Hornadys were about 4 1/4 inches apart. All this was rather astonishing to me; I was not prepared for such a remarkable result. (See table 1 for the differences).

A careful examination of the fired cases revealed a fascinating amount of



Photo 3. This figure clearly illustrates the difference of the primer conditions from the two different loading techniques. The primer on the left was fired with the rifle pointed vertical prior to firing, note that the primer is quite flat and flush with base. The case on the right was fired using the horizontal technique, note that the primer is rounded and raised above the base of the case, indicating lower pressure than the case on the left.

information. The pressure indications between the muzzle-up and muzzle-down loading positions were remarkably different. The muzzle-down cases appeared normal for a medium power, mid range load; the primers were rounded and protruding slightly, the case necks were slightly blackened, and the case expansion at the base of the case was .469 inches. The muzzle-up cases were not normal for a mid-range load in that the primers were flattened and flush with the base of the case, the necks were clean, and the case expansion was .470 inches. The .470 expansion was the same as the expansion of the original, once-fired LC 62.

Now I had the problem defined. The solution was something else again. I tried several; only one worked. I tried loading all 5 cartridges into the magazine, and then ride the bolt over the top cartridge and close the bolt on an empty chamber. This particular technique allowed me to work the bolt on the first cartridge in the same manner of the last nine, and it worked. In fact, it worked in both the 200 and 300 yard rapid fire. I was, however, not too happy with this solution because it did not solve my off-hand loading problem, and sometimes I would forget the procedure during rapid fire. What I really wanted was a load that would do away with the basic problem.

The solution, I felt, must be a load with more powder in the case, capable of the

same velocity. This could be accomplished with a larger charge of a slower burning powder. It may be helpful to remember that 41.7 grains of 4895 fills up the .30-06 case to about 2/3 of its capacity. That leaves lots of room in the case. If I could fill up that extra space somehow I would be home free. Maybe.

I was also very curious about the thousands of reloads shooters had used, years ago, with surplus G.I. 30-06's. Many shooters in this area would pull the G.I. bullet, dump the 4895 powder, replace 39 grains of the full charge, and then reseal the bullet. I wondered if these old G.I. reduced loads behaved differently, or had the same problem been with us in the "Good Old Days" and we just did not know it.

I conducted the next phase of the test by loading some more of the LC 62 cases with a powder charge that would fill the case to a higher level than the 41.7 grains of 4895, but still maintained about the same mid-range velocity that I wanted. I hunted through the loading manuals and came up with a charge of 43.7 grains of IMR 4320 with the 168 grain Sierra Matchking bullets. I also wanted to test the old G.I. reduced loads that used to be popular. I dug into my old goody box and found several boxes of Denver 43 and RA 55 ball, both of which were loaded with IMR 4895. I pulled the bullets on twenty DEN 43's and RA 55's and carefully replaced 39 grains of the

original powder back into the cases, and resealed the bullets.

One other question occurred to me concerning the G.I. loads. The old G.I. loads were, for the most part, shot in .03 Springfields. Was it possible that the difference in barrel geometry between the issue Springfield barrel and the heavy Atkinson barrel made any difference? After all, the vibration amplitudes, frequencies, and barrel bedding were vastly different between the two, and perhaps the model 70 barrel might even accentuate the difference. In order to satisfy my curiosity on this issue I decided to add the Springfield to the remaining test schedule.

Back at the range, I carried out a repeat of the first series of tests with the Springfield using the same loads and same cartridge loading techniques, again at 200 yard. The results were interesting, a virtual repeat of the Mod. 70 tests, two groups; one high and one low. Ah, well, so much for the difference in barrel geometry. Obviously it didn't matter.

The reduced G.I. loads were once again fired in the Mod. 70 using the same

Continued on next page

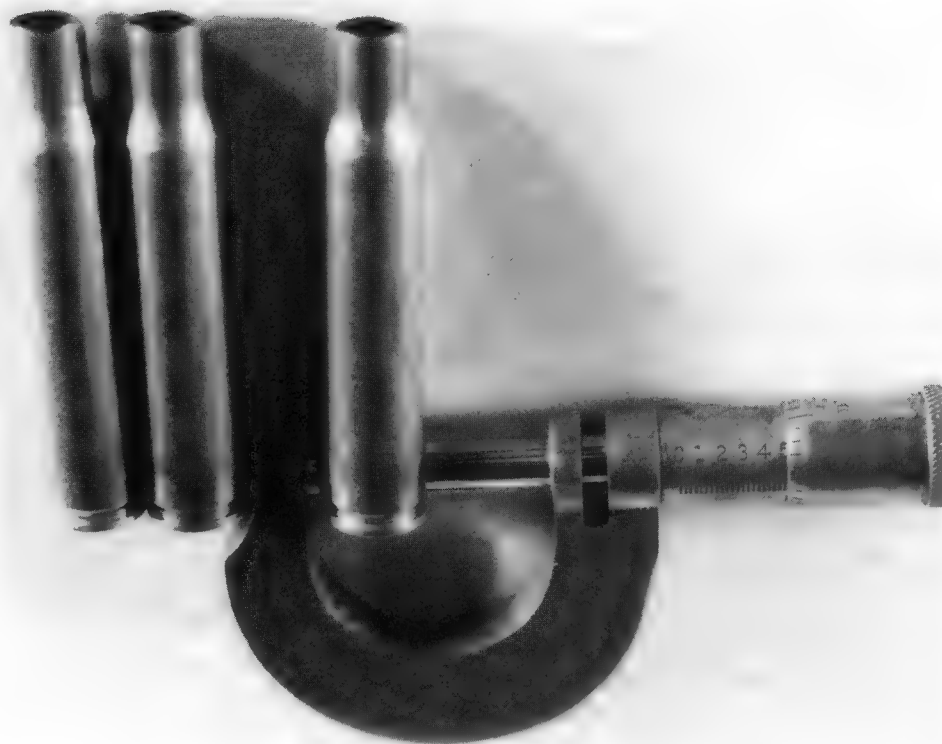


Photo 4. This photo shows the measuring technique used to measure the diameter of the base of the cases to check the pressure difference of the two different loading techniques.

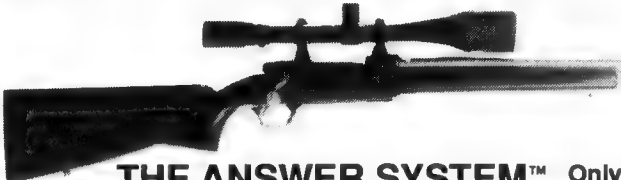
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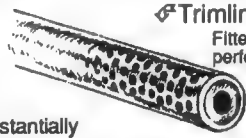
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TROUBLE IN (HIGHPOWER) PARADISE

Continued

loading techniques I described earlier. Ah, yes, the results were the same; one high group and one low group. The RA 55 ammo displayed an elevation difference of about 4 inches. The DEN 43 groups were difficult to tell apart. The group sizes ran around 6 inches and overlapped each other. Ultimately, I tried two more sets of groups on separate targets and measured a group elevation difference of about 3 inches. This smaller elevation difference may be attributed to old powder, corrosive primers... or who knows what. (See table 1 for the elevation differences). The reason we didn't see a significant difference in group size in the old days was, of course, that the accuracy of that wartime ammunition was so poor.

The loads fired with the IMR 4320 also showed up with two different groups at about 4 inches apart, so filling the case a little more did not solve the problem.

The test results strongly indicated that the barrel geometry had little effect on the test results. I reached the conclusion that this elevation phenomena was due to a pressure-velocity difference only. Now had to back up my conclusion with experimental data. I had to measure either pressure or velocity or both. I knew I could measure pressure with strain gages. I had strain gages on hand, but only static measuring instruments. I could not at the time borrow any dynamic instrumentation needed to record barrel pressure data. The only other avenue open to me was to obtain velocity, and to do this I needed an electronic chronograph. I promptly purchased an Ohler



Photo 5. This photo shows the range set up with the Model 70 Winchester, chronograph, and assistant.

and went back out to the range to conclude the testing.

I still had some loads left from the original test batch, the 168 grain flat base Winchesters, and the 168 grain Sierras. I did not have any of the Hornadys left, so I substituted some of the G.I. RA 55 with the 150 grain bullets to see the velocity difference on those.

Three of each load were fired from the horizontal position, and three were fired from the vertical-to-horizontal as I had done in the original testing. The results were as follows.

Bullet	Horizontal velocity	Vertical velocity	% Increase
Winchester	2254 FPS	2522 FPS	11.8
Sierra	2263 FPS	2520 FPS	11.4
G.I. 150 Gr.	2021 FPS	2296 FPS	13.6

The velocities were an average of three shots.

The results amazed me. I would never have guessed that such significant difference in velocity could be attained with the same powder charge by just a different powder placement in the case.

A careful reflection of all this data is now in order.

It is interesting to speculate that the same phenomena might occur in all relatively long cases, both bottleneck and straight walled. Handloaders would do well to keep in mind this problem when loading less than full density loads, particularly in medium to large cases. There is no question in my mind that benchrest shooters have already arrived at this conclusion over the years; all of the current bench rest cartridges are short and use virtually 100% loading density.

I also tend to believe that this phenomena can be partially, or entirely, the cause of the so-called detonation problem that occurs on rare occasions in large capacity cases using light charges of slow burning powder. I have read considerable published information on this occurrence, but no one I know of has done any testing with the powder at the back of the case while checking either pressure or velocity. This issue demands further testing, particularly by professional laboratories and/or ammunition manufacturers. I would also caution handloaders to be very careful to keep putting a light charge cartridge into a chamber with the powder at the base. I would recommend

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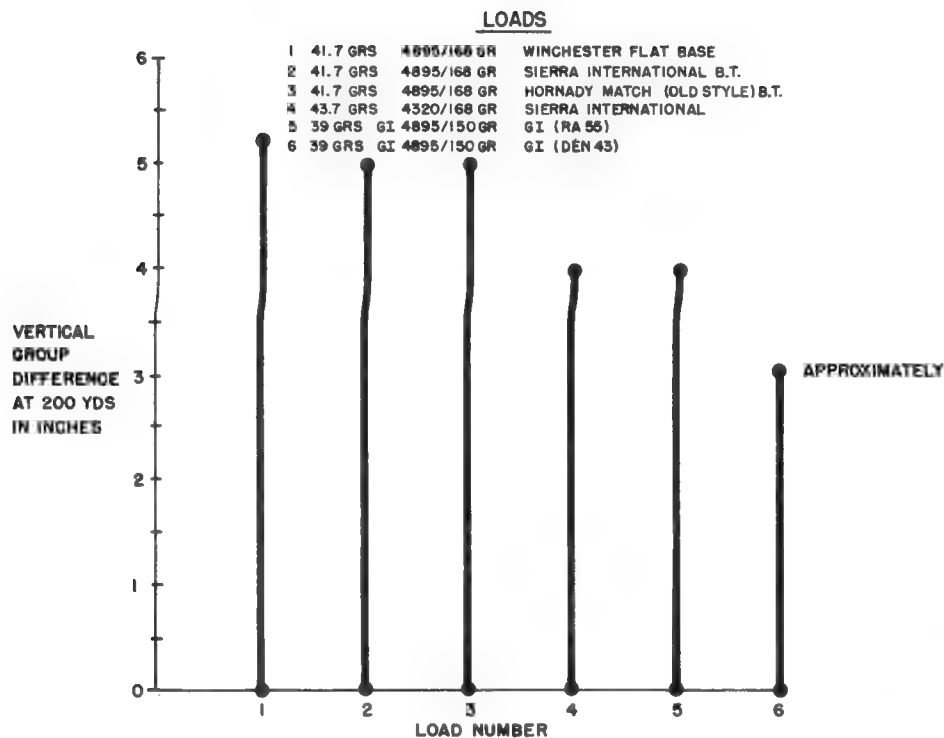


Illustration No. 1. Shows the difference in elevation of the two different groups. One fired with the powder horizontal in case and the other fired with the powder at the base of the case.

that the cartridge be pointed nose down prior to entering it into the chamber. I realize that this is contrary to the accepted practice of putting the powder close to the primer in light charge cartridges. Many shooters put the powder next to the primer in the belief that better accuracy will be obtained. My test data clearly shows that every group fired with the powder at the base was roughly twice the size of the groups fired with the powder up front; there were no exceptions. While I cannot extrapolate my data to all cartridges, it certainly bears looking into on a cartridge-by-cartridge basis. Each handloader should check this out on his own rifle if he currently follows the practice of putting powder at the base of the case.

I would like to add a few words of explanation concerning the protruding primers on the mid-range loads. I fired over 500 of these mid range loads and all of them exhibited protruding primers. In some instances I was using G.I. ball cases that had been pulled apart and reloaded with the 41.7 grains of 4895 and a 168 grain bullet. Most of the time I full length sized G.I. match cases as close to arsenal specifications as possible. After these cases were fired I only had to full length size them once every five reloads. This was done to squeeze the diameter back down to make them

easier to chamber in rapid fire. These cases never lengthened; they never grew in length from shoulder to base. Creighton Audette and I did an exhaustive search through literature available on this subject and also used our collective common sense. In the case of Creighton Audette, his shooting common sense was awesome. The conclusion was reached that when the firing pin went forward it pushed the case away from the bolt face slightly, then ignited the powder charge. We concluded that when the primer ignited, or shortly thereafter, the primer was pushed out from the base of the case and against the bolt face. There was not enough pressure in these mid range loads to stretch the case back to the bolt face and shove the primer back into the primer pocket. The fact that the cases never got longer leads one to believe this was true.

The black necks on the mid range cases were common, these black necks occurred only with the G.I. surplus or Hodgden IMR 4895 powder. The black necks never occurred with DuPont IMR 4895. The black neck indicates that there was a gap between the case neck and the chamber wall and some powder gas leaked between the case neck and chamber wall and blackened it. This also indicates that the pressure was too low to expand the case neck against the

chamber wall. That the necks did not blacken with DuPont 4895 indicates different powder dynamics or burning rates. Remember that the G.I. and Hodgden 4895 were not canister lots of powder and it would be normal to assume that they had different burning characteristics. These surplus powders certainly had different volumes in the powder measure for the same weights than that of DuPont IMR 4895. (See photo 2).

Back to solving my rapid fire problem. I hate to say it, but I solved my problem the same way the Army solved its problem with the 30-06 when they found that there was a lot of space remaining in the case when they switched to ball powder. The Army switched to the 7.62 Nato, otherwise known as the .308 Winchester. That's what I did! I use mid range loads in the .308. Do the mid range loads in the .308 cause two groups, one high and one low? Well, folks, that's another story.

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Photo 1

Harry M. Pope's Hartford, Connecticut Home and Shop Found, In Excellent Repair

by

Dave Brennan

In 1901 Harry Pope, legendary barrel-maker, and famed Schuetzen shooter closed down his gunsmithing and barrel making shop at 59 Ashley Street, Hartford, Connecticut, and went off to join the J. Stevens Arms & Tool Co., of Chicopee Falls, Massachusetts... a short-lived venture that lasted only a few years, before Harry stormed off in the general direction of California... with the Stevens folks totally convinced that Mr. Pope was an irascible old blankety-blank... and Harry Pope convinced that Chicopee Falls would be a fine setting for a filming of "Ali Baba and the Forty Thieves".

Some of the very best Pope barrels were turned out at his Ashley Street, Hartford address. The Schuetzen sport was at that time at its peak of popularity, and Harry was known nationally for both his barrel making and his accomplishments as an offhand shooter. Things seemed to go downhill for the good Mr. Pope after he left Hartford... first the Stevens debacle... then the ill-fated San Francisco stage (where the shop was leveled by the famed San Francisco earthquake (April 18, 1906) on its first day of operation!) Eventually, two long, weary

years later Harry was to set up shop at 18 Morris Street, Jersey City, New Jersey, in the third floor of the old Colgate Company building, where he would remain until his death in 1950. Certainly a very strong case can be made that, in the long career of Harry Pope... the years at Hartford, Connecticut were surely the best... from a viewpoint of productivity... accomplishment... and quality of life.

Approximately a year ago, headed for the insurance office where I was then employed, on a Saturday morning (early), for no clear reason I elected to go somewhat out of my way, and drive by 59 Ashley Street, Hartford. I knew the area to now be very much "inner city". I fully expected to see either a glass littered parking lot... or a graffiti decorated tenement building. It was rather startling (understatement) to see a fine old Victorian era three story frame house in excellent condition, complete with a "Historic Building" marker on the door jamb. High crime area or not, I parked and locked the auto, and walked up to the front of the building, staring in incredulity. Walking off to the side of the

structure (the backyard is fenced for security purposes)... dare I hope to see?... yep, there it is, a two story shop building, in excellent condition. You-know-who lived here, and in the rear building made rifle barrels that many feel have never been equaled... before or since.

I managed to talk, by phone, with the building owner, who, interestingly knew that the house had been built and occupied by a man named Pope, who had connections to the very successful Pope Bicycle Company (the makers of the Columbia line of bicycles). The house and shed had been nicely restored over the past few years, but the owner knew nothing of a famous previous tenant. It took us a full year before we were finally given permission to tour and photograph the premises (we have only a limited number of favorable attributes; one of the few is persistency). Hopefully the accompanying photos and narrative will be of interest to students of Harry Pope history.

Photo "1" shows a sign hanging in front of the house. After my visit with the house owner last year he was motivated



Photo 2

to do some research in the Hartford building records (at Town Hall). Harry Pope purchased the land, I am told, in 1880, and built the house itself (and shed) in 1885. I have no reason to doubt the accuracy of the dates given me, but I have asked for any substantiation available. Since Harry Pope was born in 1861 this means that he purchased the land (from the City of Hartford) at age 19. This however just may work out... he enrolled in MIT in 1881, you will recall. I also add that the 59 Ashley Street house would be approximately two miles from the

Hartford Rifle Club/Hartford Schuetzen Verein at Keeney Park, Hartford.. which was the rifle range mentioned in the Roberts/Waters book "The Breech-Loading Single Shot Match Rifle" where Harry did his early morning practicing. Despite Smith's book, there are no impressive "grades" between the two. The sign makes a striking item in front of the house proper... which has been extremely well restored, both inside and out. While we did not photograph the interior of the house, I can tell you that it had been handsomely done over.



Photo 4



Photo 3

Photograph "2" is a horse-holding ring, sunk into the ground near the front driveway. The City's re-doing the street in front unfortunately caused the loss of a few similar rings that were set into the curbing in front of the house.

Photo "3" unfortunately is not a color photo. There are a few stained glass windows of a kind that were "the thing" in that era in the house; this particular one is in the rear of the house. Note the bars on the windows... the house is now "inner city".

Photo "4" is a photo of the left side of the house. All ground level windows are barred. Although not all that clear in the photo, the overhang window toward the

Continued on next page

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Harry M. Pope's Hartford, Connecticut Home and Shop Found

Continued



Photo 5

left of the photo is supported by two "flying buttresses", and well-done.

Photo "5" is a hook at 3 or 4 feet above the ground, in the rear of the house. My host feels that it was another horse holding item.

Photo "6" shows what originally was the Pope stable and workshop. The extension on the left side... to the left of the three garage doors, is a halfway recent addition. At ground level the two doors to the left (which were originally "split down the middle" swinging garage doors, rather than their modern replacement "overhead" types) were certainly horse stalls, as there is plenty of evidence of stall dividers, etc. therein. The stall to the right side of the photo I suspect was used for general storage. The "people door" was on the right side of the building, and not visible in this photo. The right stall had a set of stairs going to the second floor, along the right side wall. That right stall apparently had a stove of some sort... which had a stovepipe that pierced the second floor. That opening, sheet metal or tin lined, remains today. The main working area of the upstairs shop was right behind the swing-open second story door. There was originally a hoisting arm at the top of that window. The area of the upper right in the photo was, as I said earlier... the main shop area. There are a number of



Photo 6



Photo 7

spots there where machine tools were bolted down, and the floor is pierced in a few spots for belts and pulleys. In the roof area above the second story swing-open door was originally a large skylight. When the present owner had the roof replaced (they found five layers of roofing tiles in place, one on top of the other) they unfortunately did not replace that

skylight, which one has to suspect was built in deliberately for the additional light it would put on the machinery. The house faces north, by the way.

The strange shaped hole-in-the-wall that is shown in photo "7", is cut in the left side of the wall, perhaps two feet from the front, on the left side of the original building (which of course put it now

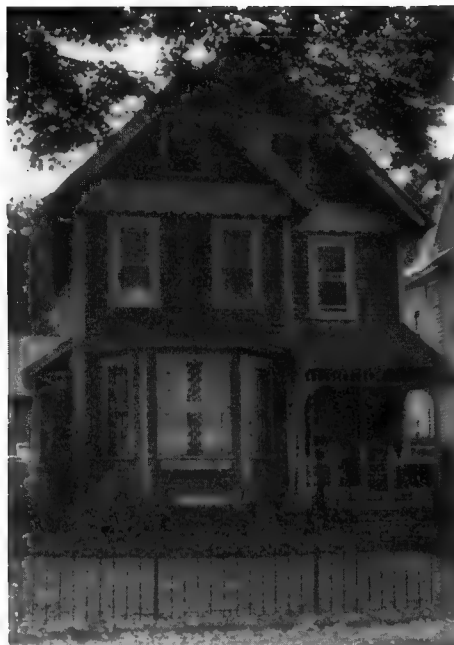


Photo 8



Photo 9



Photo 10

inside the shed addition). Since this was a "horses" area, I have to suspect that it was horse-connected.

Photo "8" is a head-on shot of the house... which is today re-painted in what is believed to be the original colors... a milk-chocolate brown, with a light tan trim. Just barely visible is a "historic building" marker on the right side of the main door. The "Pope" sign unfortunately blends into the background here... it stands just to the left of the porch.

Photo "9" is the rear of the house. The two upper porches are modern additions. The stained glass window shown previously now appears under the lower of the two porch additions. Photo "10" shows that side of the shed that was previously hidden, in photo "6". The door may well be the original door. The lattice work is more recent.

Photo "11" shows the rear of the shed building. The owner tells me that there were originally three smaller sky-lights here, that were not replaced when the building was re-roofed. He also told me that there had been a certain number of windows on the second floor that had been covered over at some point in the building's past. Quite interestingly, those original windows appear in the photo... although they are not visible to the naked eye! Obviously Harry wanted to get as much illumination out of the sun, from a southerly direction, as he could.

Photos are by Studioworks, 387 Soundview Road, Guilford, CT 06437, phone (203) 453-2751.

There have apparently only been three



Photo 11

owners of the house prior to the present owner. Harry must have sold the house on his going to Stevens around 1901. One of the two subsequent owners (prior to present owner) was reportedly there for something like 60 years.

The house will be put up for sale next spring. Present asking price is \$165,000. While the house's provenance is magnificent... it's still an "inner city" location.

I asked the building owner if he had formed any impressions of the original owners (Pope) when restoring the house.

He remarked that a number of objects found in the floors and walls suggested that the owners were "rather poor, as things go".

It would be about two miles north to Harry's rifle practice range, and less than a mile south to the Pope Manufacturing Company where Harry Pope worked before becoming a full-time gunsmith, which was located mainly on Capitol Avenue.



SLICK BULLETS

by
Terry Wright

Cast bullet shooters lube their bullets to get better accuracy, less barrel fouling and more velocity, so why shouldn't jacketed bullet shooters lube theirs also? For years I had often wondered about lubricating jacketed bullets but didn't know how to really go about it or even what to use for a lube. For that matter, I wondered if lubricating jacket bullets was even practical. I had never seen or heard of anybody doing it.

Some time back there was some talk about using Friction Block in the bores of your guns. I tried this but couldn't get consistent results. The problem with lubricating the bore is that unless you relube the bore after every shot you fire, you lose your consistency. It seems to me that with each shot some of the Friction Block is going to disappear as the bullet proceeds down the bore. Putting lube on the bullet means that each shot will be the same every time. In other words, you have a fresh batch of lube for each shot. Cast bullet shooters proved that was the way to do it over a hundred years ago.

Fortunately for people like me who wonder about these things, there is a company by the name of NECO that has been lubricating jacketed bullets with molybdenum for some time now. From what I've been able to learn, the results using Moly have been quite encouraging. I read with great interest Dan Hackett's article in Nov. 1994 PS about using bullets lubed by NECO in his .25-06. From what I gathered from Dan's article, his .25-06 shot the coated bullets really well. He shot some 500 yard targets that were quite impressive, to say the least. This, and a couple of other articles, convinced me that I wanted to at least try some coated bullets in a couple of guns and see what the results would be.

NECO will coat bullets for you, if you like. I didn't want to go that route because of the many different combinations I wanted to try. I had several guns in different calibers shooting different bullets. In my situation it would be better if I coated them myself. That way, I could test as many or few combinations as I wanted. With that in mind, I called NECO and ordered one of their kits.



After getting the kit in hand, I read the directions completely through. (Editor: Faint heart!) This is one of those times you don't want to skip the directions. There is some good, solid info in these directions that you should know. If you do decide to try one of their kits do take the time to read all of the info they provide. (Editor: This of course flies in the face of all that PS has always taught you...)

The kit consists of two containers of small steel shot. This is what's used to apply the Moly and the wax. Also contained in the kit is a container of Moly, a container of carnauba wax, and some very fine corn cob grit.

In order to coat the bullets with Moly they must be tumbled in a tumbler containing the bullets, steel shot and the Moly. I used a vibratory unit instead of a regular tumbler. This worked out fine. A word of caution here. I would recommend that you buy an extra bowl for your unit. The reason is, that once the steel shot and the bowl are coated with the Moly, there is no point in having to completely clean the bowl so that you can use the steel shot containing the carnauba wax. You cannot mix the two in any way. It, of course, would contaminate both of them. By using a separate bowl

for each operation, it's fairly simple to keep everything in it's proper place. Steel shot and Moly in one bowl, and steel shot and wax in the other bowl. I bought a Ultra-Vibe 10 unit from The Silhouette. Then I called Ultra-Vibe and ordered an extra bowl just for this purpose. It only takes a minute to change the bowls back and forth.

Coating the bullets is a very straightforward operation. Dump one container of steel shot in a clean uncontaminated bowl. Add half as much Moly as they tell you in the directions. (Editor: Okay, now you're starting to get some respect back, kid...) Also add just a small amount of fine corn cob grit. The grit keeps the excess Moly off the bullets. You can add more Moly or grit later if you need to. Add the jacketed bullets you are going to coat. The amount of bullets will depend on how many your unit can handle. Two or three hours vibration time seems to work fine for me no matter what diameter, weight, or how many bullets are coated at one time. You may want to consider a timer for your unit just in case you're not around when the time is up.

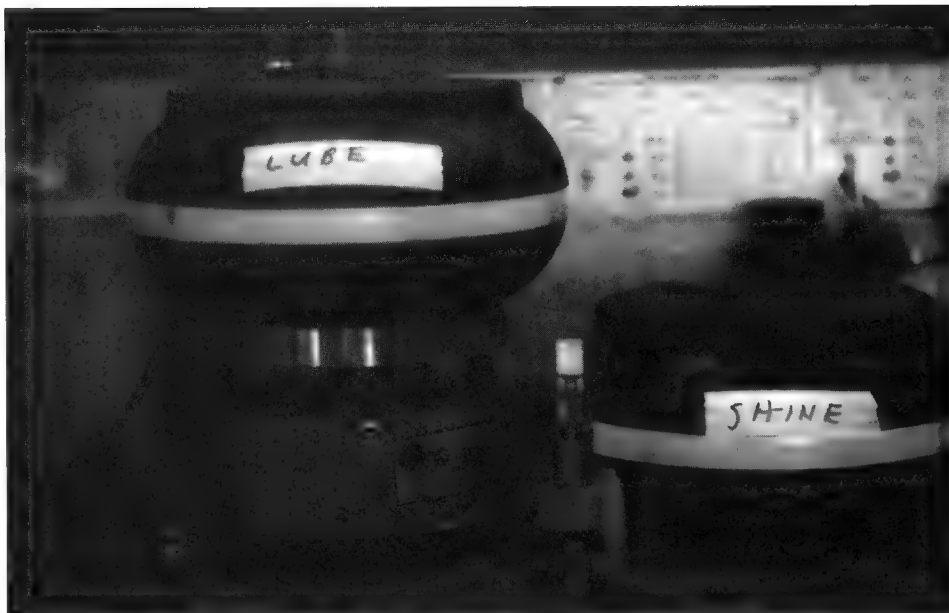
Next, dump the second container of steel shot into the second clean uncontaminated bowl. Add the Moly coated bullets and HALF as much Carnauba wax as

they say in the directions. (Editor: Remember "Rebel without a Cause"? We could be looking at the next James Dean here.) Also add just a taste of corn cob grit. Both the Moly and the wax come as a very fine dust of flour-like consistency. It takes just a tiny amount to do the job. In this situation, an hour of time seems to be plenty to coat the bullets with wax.

If you do it right, the bullets come out looking really nice. They will have a dull gray, smooth finish. If you get too much wax on the bullets, like I did the first time, they come out sort of bumpy looking or "unsmooth". Running the bullets in a DIFFERENT vibrator with regular corn cob grit for two or three minutes will remove the excess wax.

The reason for coating the Moly lubed bullets with wax is to keep the Moly on the bullets and off everything else. Without the wax, the Moly will get on everything they touch, including your fingers.

Once you have the bullets coated then you can do some serious test work. The guns tested were a couple of seven millimeter single shot handguns used for Silhouettes, and my light varmint bench gun. The first gun tested was a 10 inch TC barrel chambered in 7MM/Super Mag. The 7MM/Super Mag is a 357 Super Mag (Maximum) necked down to seven millimeters. It has about the same powder capacity as a 7 TCU. TC made a limited run of the 7MM/Super Mag barrels a few years back. This particular barrel had a point-of-impact change problem. With a clean barrel, the gun would put the first five shots in a different place than the second five shots. This, of course, made it just a bit tough to get it sighted in. Actually, it took about twenty shots for the barrel to really settle down and become predictable. By that time I was already into the Turkeys; a little late, seemingly. I figured the problem with the barrel was that, for some reason, it wouldn't settle down until there was a certain amount of carbon build up in the throat. At any rate, the gun would shoot about two to three inch groups at a hundred yards with a scope mounted, off sand bags, with uncoated bullets. Not real good, seemingly. With the Moly coated bullets, the groups improved to less than two inches at one hundred yards. Most importantly, with the coated bullets it does not change point of impact after the first five shots. It will put the first five, the second five, the third five, etc., in the same place every time. This alone is worth the investment. Last, but not least, the copper build-up in the bore



is less with the Moly coated bullets. The Moly seems to work it's way into the metal inside the barrel. This TC barrel seems to be a little rough inside, so any improvement in this area is nice. The Moly coated bullets have definitely made cleaning the barrel easier.

The second gun tested is also a TC barrel. This barrel is an after-market barrel chambered for 7MM E.T. Gates. That's a 375 Super Mag case necked down to seven millimeters. It has about the same case capacity as a 7BR, but with a rim. This custom TC barrel shot very well right from the start. It would shoot half inch groups at fifty yards, and groups just over an inch at one hundred yards. I was really curious to see if the Moly would help a barrel that shot reasonably well. I really didn't think it would, but, lo and behold, it did! The groups did not improve a great amount, but they did improve just the same. The barrel will now shoot groups in the fours at fifty yards, and is now a good solid "inch" gun at one hundred yards. Barrel cleaning with this barrel also improved somewhat. This barrel did not copper foul all that badly to begin with. However, after shooting the Moly coated bullets, the copper fouling was a bit less yet.

The third gun to get a trial run was my light Varmint rifle. It is a switch barrel rifle consisting of a Panda action, McMillan benchrest stock, Jewel trigger, Kelbly rings, and a 36 power Leupold scope. One of the Hart barrels I have for the gun is a .22 BR with .2425 neck. The barrel has been used mostly as a test bed for me to try different things. The result of all this testing is that the barrel has gotten a

lot of rounds, upwards of three thousand, put through it. As you can imagine, it has lost some of it's accuracy edge. Be that as it may, I thought this barrel would be a good candidate for testing lubed bullets. The other thing was that this barrel has been a fouler right from the start. No matter what I tried, it would copper foul within a very few shots. I wanted to see if the Moly would help the fouling problem any.

The big problem here is how to do a well regulated, meaningful test. Here we have a rifle capable of shooting some good groups so the test has to be done right if we are going to learn anything. Once you shoot the lubed bullets in your barrel some of the lube is going to be left in the barrel. This means that you can not shoot a five shot group with lubed bullets, then go back and shoot a five shot group with unlubed bullets. The small amount of lube left in the barrel would effect the second test. Even if you clean the barrel between groups, some would be left embedded in the barrel. So, the problem becomes how to do a controlled test. Right off the top, one would think that the best way to do a controlled test would be to go out early in the morning and shoot five, five shot groups at one hundred yards, and do the same thing at two hundred yards, with plain bullets. Then come back and do the same with lubed bullets. This won't work for a very good reason. By the time you get around to testing the lubed bullets it would be afternoon. By that time the conditions would have changed. The test would be meaningless.

Continued on next page

SLICK BULLETS

Continued

The only way I could see to keep the test in a controlled environment at all was to first establish what the gun was capable of at both one hundred and two hundred yards, on average, on any given day. In other words, what size groups will the gun shoot at these yardages, day in and day out. Then, start a test session using the lubed bullets over several days to see what change, if any, had taken place in average group size. This was

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the way the test was done for all three guns.

As mentioned earlier, the barrel has had a lot of rounds through it. While new, the barrel would shoot quarter inch groups, or a little better, at 100 yards. Not good enough to win matches, but certainly good enough to learn from. Now the barrel shoots in the threes at 100 yards; definitely time for retirement from active competition, but still good enough to experiment with.

The rifle was taken out on three different days and shot at both 100 and 200 yards. Nine groups were shot at each range (three each day) with plain bullets. The average size at 100 yards was .336. At 200 yards it was .781. Next, the rifle was tested on three different days, at both 100 and 200 yards, using Moly coated bullets. I fully realize that shooting on six different days is going to cause the test to be tainted somewhat. But there was just no other way to do it. Three different days to establish an average with non-coated bullets, and three different days to establish an average with coated bullets. The test was done in the early fall, with all six days being relatively the same. The test was conducted early in the morning before the wind and heat became as much of a factor as it does in the late afternoon. Therefore, I believe what I learned was valid.

The average group size at one hundred yards with coated bullets was .330, just a hair better than with the non-coated bullets, or, for all practical purposes, about the same. At two hundred yards, however, there was a change. The group size shrank from .781 down to .736, a difference of fifty thousandths of an inch. I'll take fifty thousandths of an inch improvement in group size anytime.

I can't tell you why the barrel stayed about the same at close range and improved at long range, but there are a couple of hints as to why that is. First, there is reason to believe that coating the bullets improves the ballistic coefficient somewhat. High Power shooters tell me that at six hundred yards some rifles will print groups higher on the target with Moly coated bullets. This means the remaining velocity is higher. This could mean that my two hundred yard targets were better because the bullets are slicker and buck the wind a little better. Second, if you load non-coated and coated bullets with the same powder charge, the coated bullets will show a lower velocity. In the .22 BR this amounted to about sixty FPS. I had to load about a half a grain more to maintain the same velocity as with the non-

coated bullets. The folks at NECO tell me the reason for the slightly lower velocity is that the coated bullets are of course slicker. Slicker bullets have less friction resistance. This means that they move down the barrel easier. With less resistance, the powder gases cannot build as much pressure, thus the lower velocity.

The slicker bullet offers one more advantage. You can sometimes shoot the coated bullet a little faster than the non-coated variety. Because the coated bullet builds a little less pressure you can sometimes up the powder charge by a small amount (compared to what you can get away with when using non-coated bullets).

Now that I have a few groups through the barrel using the Moly coated bullets it's easy to see what's happening with the fouling. The more I shoot the barrel the less it fouls. I suspect that enough of the Moly is being impregnated into the walls of the barrel to help keep the fouling down some. The test with the two 7 millimeter handguns and this rifle has prompted me to try some other rifles. This test has given me every reason to believe that the Moly coated bullets do have an accuracy advantage in some barrels. In no test case have I seen the accuracy deteriorate. It has always been at least as good, and, in some situations, a little better. Not only that, but there is the possibility that by starting out with a new barrel, one could end up with a very accurate barrel that does not copper foul so readily, if at all. I have, at this point, learned enough that I'm going to try it in a new barrel. There is every possibility that this process may not improve the accuracy at all in some barrels. In some guns the improvement may only be slight. Or, as in the case of the first TC barrel tested here, it may help quite a bit. NECO also sells lapping kits to smooth out rough barrels. The first TC barrel could have probably benefited from a little lapping before using the Moly coated bullets.

If you are interested in doing a little experimenting with coated bullets give NECO a call. They are very helpful and will answer your questions for you.

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Forming the Locking Lug Runways in Homemade Receivers

by

Dr. K.W. Erickson

There seems to be a good deal of interest in fabricating homemade receivers and actions among the serious rifle shooters and amateur gunsmiths, judging by the articles and photos in "Precision Shooting." The article by James Higley on "Internal Slotting" in the January issue deals with the biggest stumbling block that faces the gunsmith-machinist, namely how to form the locking lug runways. I have made a number of homemade actions over the past 30 years, using military or commercial bolts, with a considerable amount of success, and it has been a source of pleasure to display these at gun show tables and the NRA Gunsmith School short courses. They always attract a lot of attention from other enthusiasts, and the first question I am always asked is "How do you broach the locking lug runways?" Well, I don't; I use an end mill in a vertical milling machine.

I wish I could claim credit for this idea, but the revelation hit me while I was examining a 300 meter free rifle action imported in the 1950's by Dr. Emmet Swanson. Doc had originally seen one of these actions in use by a French 300 meter shooter. Inquiry disclosed the fact that these were hand made by a Finnish gunsmith by the name of Leskinen, and Doc made contact with him and arranged, after considerable persuasion, to have 3 of them made. One went to Doc, the other two went to Elmer Franzen and Bob Sandager, both of whom were also 300 meter free rifle shooters. The actions were barreled and stocked and finished up as 6.5-55mm 300 meter free rifles and used for many years with great satisfaction.

I had many opportunities to examine these beautifully crafted rifles over the years, and was very much impressed with not only the workmanship but the clever innovations — remember this was in the 1950's. The first thing that one saw was the most obvious; the loading port was on the top of the action, and the locking lugs on the bolt were positioned so that they moved back and forth in the vertical position, and locked horizontally. Since all the firing is done with iron sights, this was not too much of a prob-

lem in loading and extracting, with no scope to interfere. What was more important was the even load put on the receiver when a heavy barrel was installed. Presumably this would be a better engineering principle than our modern method of allowing the top lug of our bolts to take most of the load when a heavy barrel is installed. Another feature which can only be seen by removing the stock, is the large, wide and shallow groove on the bottom of the receiver. This is used as a recoil lug, except that the wood of the stock fits up into the groove instead of our more common practice of using an exterior lug that is mortised into the wood. As can be seen in the accompanying photo, the extractor is not fastened to the bolt, but rides in the bottom of the lower locking lug runway, and is activated by the bottom lug itself.

Perhaps the most interesting feature is the fact that the lug runways are formed by the use of an end mill in the vertical milling machine. As can be seen in the photos, the gunsmith merely plunged down from the top with the end mill to form the loading port, and continued down to form the lower locking lug runway. It is necessary to run the forward end of the cut slightly more than half the diameter of the end mill into the locking lug shoulder recess in the receiver in order for the bolt to go all the way forward and rotate locked. The slotting in the top of the underside of the rear receiver bridge, for the top bolt lug to pass, is similarly formed from the bottom of the receiver, and the slot in the bottom is later filled by the trigger assembly. The only other problem is that of the bolt stop; he solved that by the use of the spring loaded plunger seen ahead of the trigger assembly. This disengages the sear and tips it to the rear, as can be seen in the photo, and permits the bolt to be withdrawn.

Several of the features are probably less than desirable, and have proven to be a nuisance. The extractor merely pulls the case out of the chamber, where it is necessary to reach in with a small finger and fish it out. Likewise the loading port being on the top of the receiver pretty

much precludes the convenient use of a scope, which of course is a nice thing for load development. The first action I made had this design, and while it shot very well indeed, it was just about impossible to use with a scope. The method of bedding employing the large groove on the bottom of the receiver into which the wood was fitted, turned out to be less than durable. Fortunately, the later use of the new glass bedding has more or less solved that problem. As can be seen in the photo, there is an oval slot in the bottom of the receiver just ahead of the trigger assembly. The owners of these rifles were not certain as to its purpose, since it did not appear to be necessary for the machining process. It was thought that perhaps it was for an exterior recoil lug embedded in the wood, like Anschütz uses.

The key to the whole concept however, is the use of an end mill in the vertical milling machine to form the lug runways. The first one I made copied the idea used here, with the loading port on the top. I cut a Springfield bolt in two, had it heli-arc'd back together with the lugs rotated 90°, shortened the firing pin, and used it in that form. It worked out quite well, but the action had the disadvantages previously mentioned. It then occurred to me that it would be a much simpler procedure to do this from the side, as with our conventional bolt action rifles of today. I have made a number of actions this way, and they have worked out very well. It also has the significant advantage of being able to use most commonly avail-

Continued on next page

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Forming the Locking Lug Runways in Homemade Receivers

Continued

able military and commercial bolts without alteration.

The photos of the action shown, were taken by the original owner, Bob Sandager, and should give a good idea and perspective of the design and necessary machine work involved. Photo #1 shows the left side of the action with bolt open. The trigger assembly, with the sear swung back out of the way for bolt removal, the bolt, release, and the top of the upper locking lug, can be seen. Photo #2 shows the action from the top, with the bolt open, showing the extractor lying in the bottom of the lower lug runway, just ahead of the bolt itself. The method of forming the lug runways is clearly demonstrated here. Photo #3 shows the action from underneath, showing the method of trigger attachment, bolt release, and the recoil lug groove. Photo #4 shows the receiver without the bolt, again illustrating how the end mill cuts the lug runways. Photos #5 and #6 show the bolt, with the extractor and the method used to activate it. The cocking piece projects down off the firing pin body.

The nicest part of this type of action-making is that it can all be accomplished with a lathe and vertical milling machine. No special tooling is required other than drills, reamers and taps, with one exception, and that is easily made in the shop. The exception mentioned is the cutter used to bevel the locking lug shoulders in the receiver that permit the bolt to close. For those who have the shop facilities and enjoy making things, or for those who have more time than money, it is a fun way to perhaps make a Palma type action, or perhaps even a benchrest action. So make chips!



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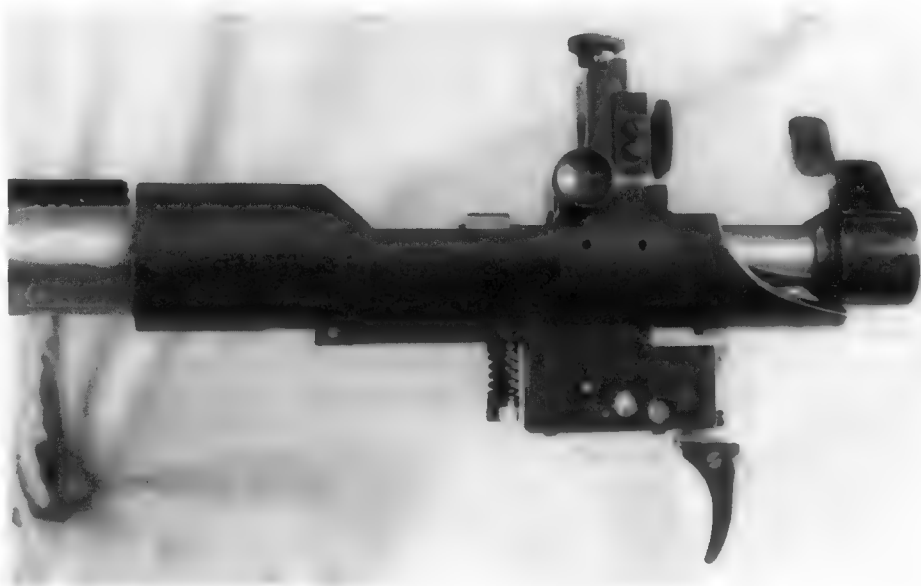


Photo #1

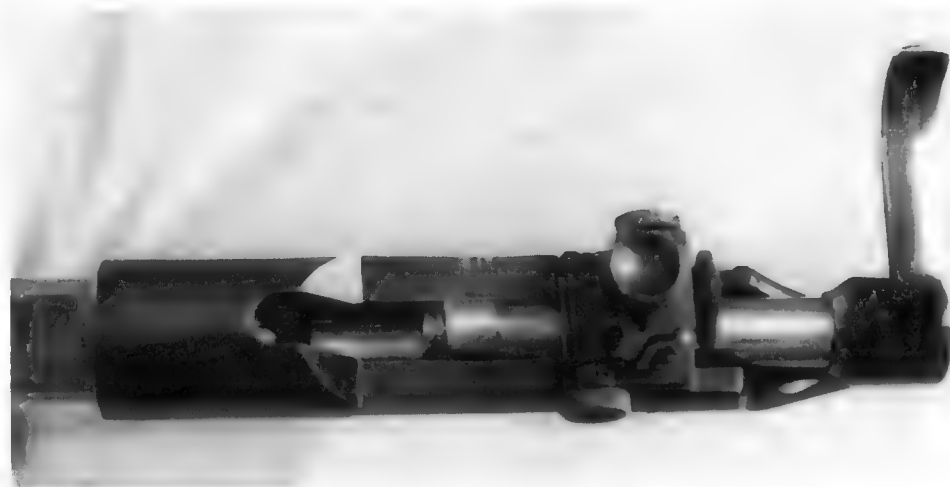


Photo #2

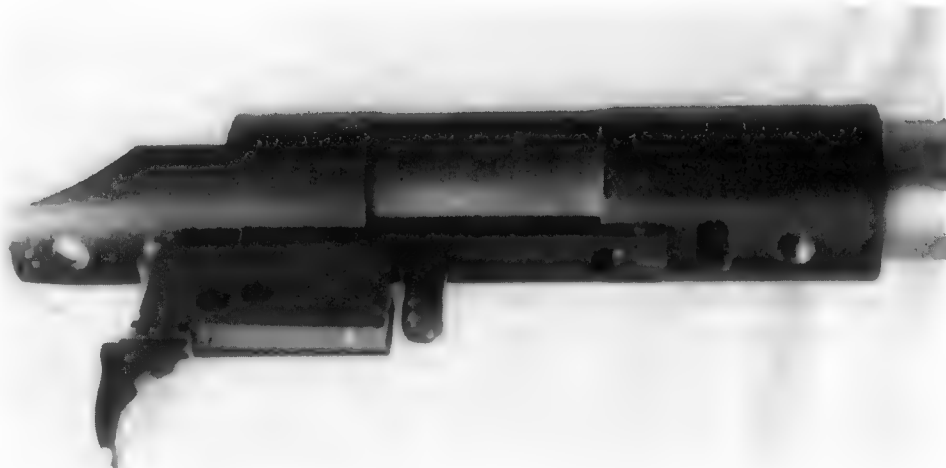


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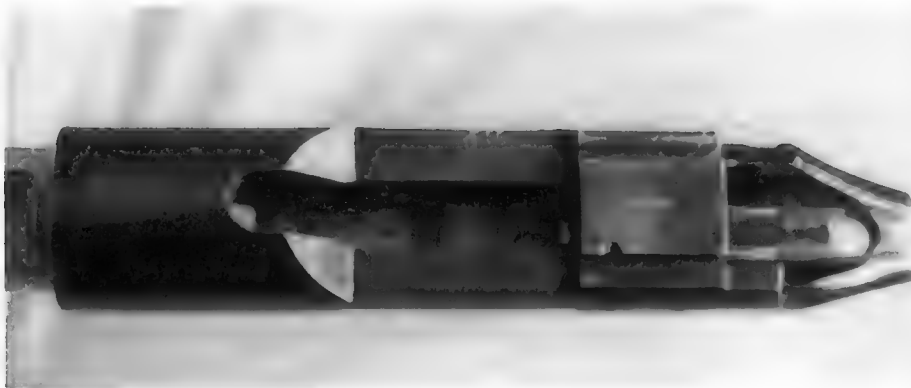


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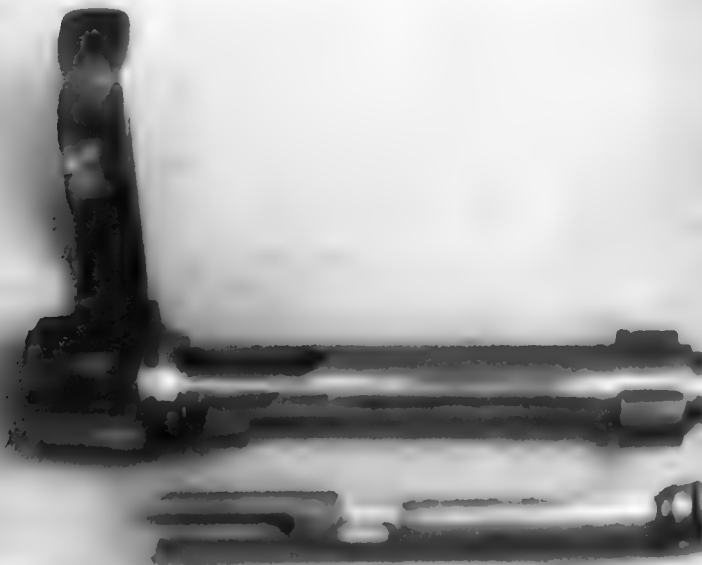


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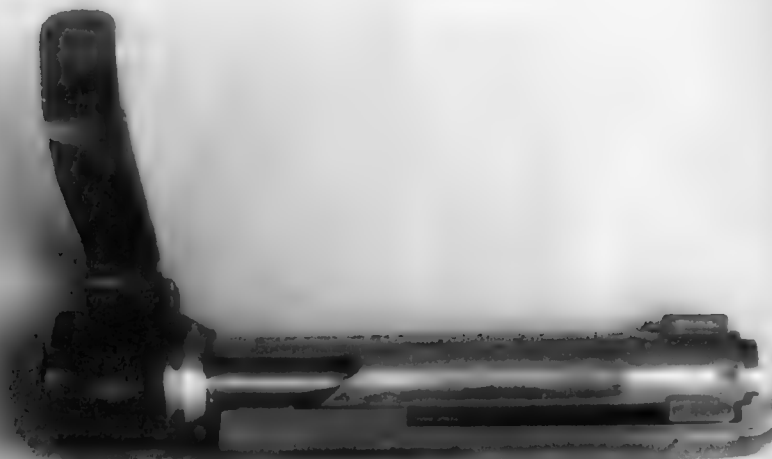
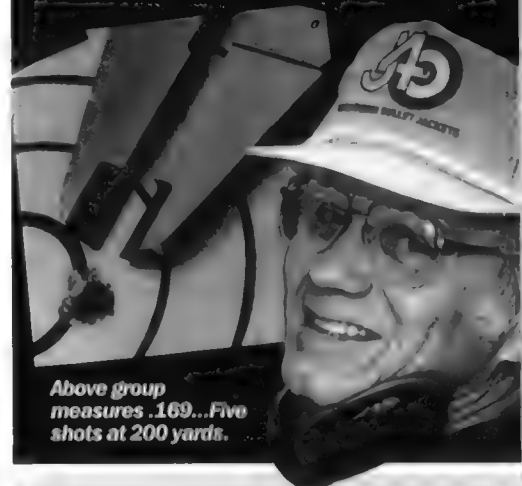


Photo #6

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EXTERIOR BALLISTICS AND WIND DRIFT OF CALIBER .22 LONG RIFLE MATCH AMMUNITION

by

Robert L. McCoy

Olympic smallbore shooters fire .22 caliber bullets on outdoor ranges at targets 50 meters away. Firing is normally done from a shooting house that is closed on three sides. Wind flags are placed down range between each firing point, at 10 meters and 30 meters distance from the firing line. The shooters need to be able to accurately predict the effect of wind on the bullet's flight, and to properly compensate for that effect in order to be successful.

In May 1989, Dr. Henry D. Cross, III (who at that time was the Chairman of the U.S. Shooting Team) sent a letter to Dr. John Frasier, Director of the U.S. Army Ballistic Research Laboratory (BRL). Dr. Cross requested the BRL's assistance in making a highly accurate quantitative determination of the wind effect on .22 Caliber Long Rifle match ammunition used by U.S. Olympic shooters.

On July 15, 1989, a meeting was held at the BRL, to discuss the Laboratory's technical assistance to the U.S. Shooting Team. The meeting attendees included Dr. Cross, Dr. Frasier, Mr. Ray P. Carter of the U.S. Shooting Team, Ms. Marsha Beasley, National Women's Champion smallbore shooter, and the author. Dr. Cross formally requested assistance from the BRL, and after some discussion the project was approved. The author was assigned the task of conducting a limited test firing program of .22 caliber match ammunition in the BRL Aerodynamics Range.

The test plan included firing the two commercial brands of .22 caliber match ammunition that were in common use at that time by U.S. Olympic shooters; the British Eley Tenex and the West German RWS R-50. We decided to test two rifles, to determine if different guns produced any significant differences in the aeroballistic characteristics of the bullets. Two Olympic-grade match rifles — an Anschutz Prone Rifle and a Shilen-barreled Remington 40-X Rifle — were obtained on loan by Ms. Beasley. Both guns were rifled with 1 turn in 16", right-hand twist. All the test firings in the BRL Aerodynamics Range were conducted during the first half of September, 1989.

The BRL Aerodynamics Range is an enclosed, climate-controlled firing range, which is instrumented with spark photography stations to record the motion of the bullet over 100 yards of its flight. The measurement accuracy of the range is ± 0.01 inch in downrange distance, ± 0.5 microsecond in time, and ± 0.1 degree in pitch and yaw angles. The high-precision measurements permit determination of the drag (or ballistic coefficient) with an error less than 1%, and the gyroscopic stability factor to within 2% error.

Physical measurements were taken on a sample of three rounds each, for the Eley Tenex and the RWS R-50 bullets. The physical measurements included bullet weight, length, diameter, center of gravity location, axial and transverse moments of inertia, and ogive contour coordinates from a Mann Optical Comparator. Figure 1 is a sketch of the Eley Tenex bullet,

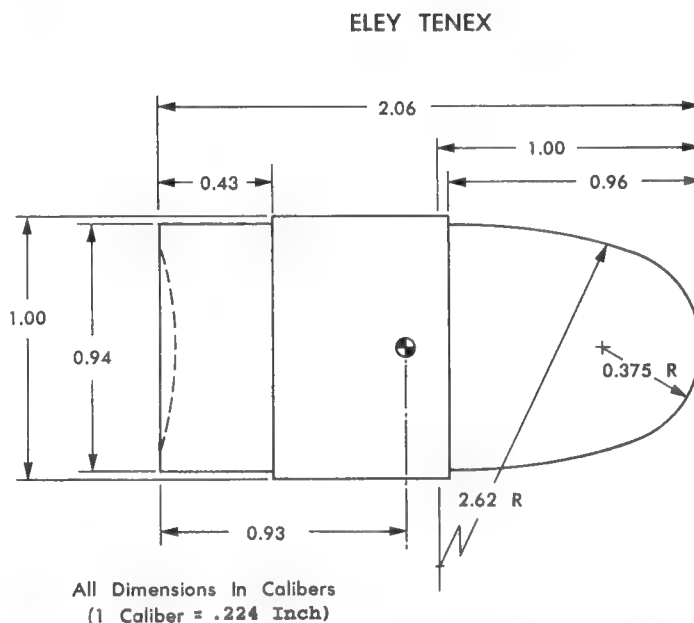


Figure 1. Sketch of Eley Tenex Bullet

showing average dimensions; the dimensions of the average RWS R-50 bullet are nearly identical.

In order to measure the lift coefficient, the overturning moment coefficient, and the gyroscopic stability factor, we had to induce a small amount of yaw into several of the flights, which was accomplished by means of a "tipping card." Yaw levels of three to five degrees were obtained by firing several of the rounds through a thin sheet of cardboard, placed fifteen feet downrange from the gun muzzle, at a forty-five degree angle to the trajectory. (Normal first maximum yaw levels, without the tipping card, varied between 0.6 and 1.5 degrees, from both rifles).

An interesting and useful by-product of spark photography range testing is the high quality flowfield visualization provided by the spark shadowgraphs. Figure 2 is a shadowgraph of the Eley Tenex bullet at Mach 0.95 (1064 fps at standard atmospheric conditions). If the muzzle velocity (MV) is 1090 fps, the flowfield of Figure 2 would be observed about 15 yards downrange from the gun muzzle. This shadowgraph shows that the flow expands around the spherically blunted ogive, and becomes locally supersonic at the ogive-cylinder junction. The flowfield over the entire cylindrical afterbody is locally supersonic, as is confirmed by the presence of Mach waves. A strong shock wave is formed near the base of the bullet, which returns the flow to locally subsonic speed. The turbulent wake behind the base is a low pressure region; at Mach 0.95 the base pres-



Figure 2. Shadowgraph of Eley Tenex Bullet at Mach 0.95

sure is approximately 15% below the free-stream static pressure, and over 60% of the observed total drag is due to the base drag contribution.

Figures 3 and 4 illustrate the progressive decay in shock wave strength with decreasing Mach number. Figure 3, taken at Mach 0.90 (1008 fps at standard conditions) shows a small triangular-shaped pocket of locally supersonic flow, which shocks down to subsonic speed roughly half-way down the cylindrical center section of the bullet. This shadowgraph shows the flowfield that would be observed approximately 50 yards downrange from the gun muzzle.

Figure 4, at Mach 0.87 (974 fps at standard conditions) shows only a tiny pocket of locally supersonic flow, and a very weak shock wave which occurs about one-third of the way down the bullet's cylindrical afterbody. Figure 4 illustrates the flowfield that would be observed approximately 75 yards downrange from the muzzle. At flight speeds below Mach 0.80 (downrange distances beyond 140 yards) the bullet is in totally subsonic flow, and the shock waves disappear.

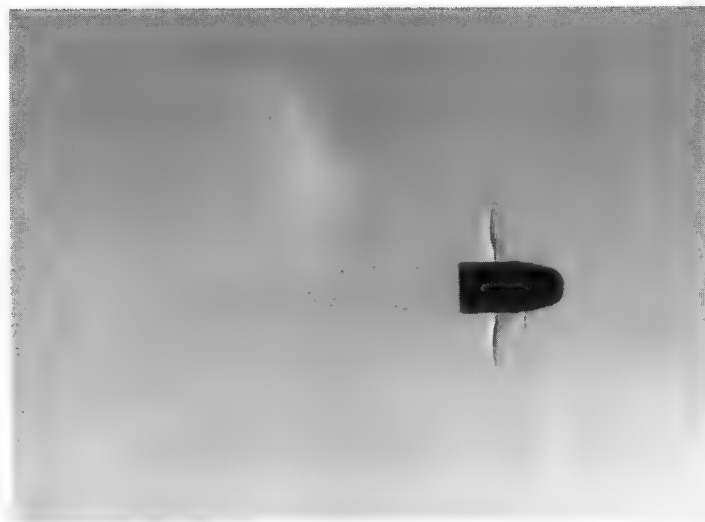


Figure 3. Shadowgraph of Eley Tenex Bullet at Mach 0.90



Figure 4. Shadowgraph of Eley Tenex Bullet at Mach 0.87

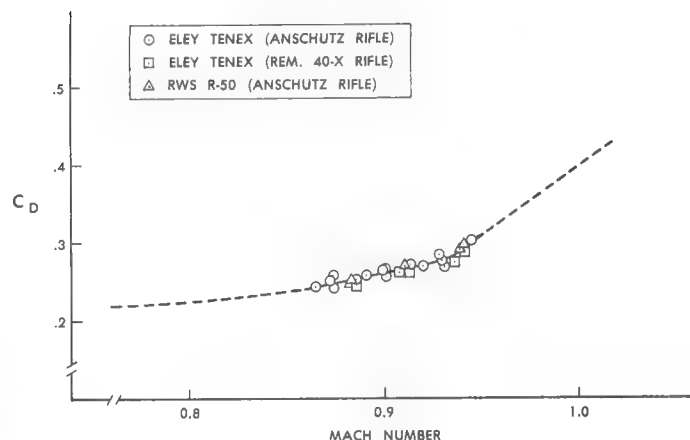


Figure 5. Drag Coefficient versus Mach Number, for Eley Tenex and RWS R-50 Bullets

Figure 5 is a plot of the aerodynamic drag coefficient, C_D , versus the flight Mach number, from the spark range measurements. Eley Tenex ammunition was tested in both the Anschutz rifle and the Remington 40-X rifle; the RWS R-50 ammunition was tested only in the Anschutz rifle. Figure 5 shows that there is no significant difference between the two rifles, firing Eley Tenex ammunition, or between Eley Tenex and R-50 when shot from the Anschutz rifle. The drag coefficient data plotted in Figure 5 suggests that Eley Tenex ammunition fired from the Remington 40-X rifle gives slightly less drag than the same ammunition from the Anschutz rifle. However, a statistical analysis indicated that the difference (less than 1%) is insignificant. The statistical analysis also showed that the round-to-round standard deviation in C_D for both ammo types is 0.005, or about 2%. The conclusion is that choice of rifle or brand of match ammunition used has an insignificant effect on the wind sensitivity of caliber .22 Long Rifle bullets used in Olympic competition.

Continued on next page

EXTERIOR BALLISTICS AND WIND DRIFT OF CALIBER .22 LONG RIFLE MATCH AMMUNITION

Continued

Modern commercial exterior ballistic software for personal computers is nearly always based on the U.S. Army's G_1 drag function, which was used for Ordnance calculations from about 1918 to 1960. Although military ordnance no longer uses this old drag function, it has become the defacto standard for U.S. sporting use. The drag coefficient data plotted in Figure 5 have been converted to form factors and ballistic coefficients relative to G_1 , for the benefit of those smallbore shooters who would like to have the most accurate values to input into their commercial exterior ballistics software. Table 1 lists the appropriate form factors and ballistic coefficients to use for various target ranges, at sea-level, standard atmospheric conditions.

Table 1		
Form Factors and Ballistic Coefficients for .22 Caliber Match Ammunition		
Range to Target	Form Factor (G_1)	Ballistic Coefficient
50 Meters	.765	.149
50 Yards	.765	.149
100 Yards	.776	.147
200 Yards	.797	.143

Note that the form factor and the ballistic coefficient change slightly for different target distances. The reason is that the shape of the G_1 drag coefficient versus Mach number curve is somewhat different from that shown in Figure 5. (The last row in Table 1 is included, in case two-hundred yard smallbore shooting ever comes back!)

In addition to the drag coefficient, the spark range firing data provided accurate measurements of the aerodynamic lift force coefficient, the overturning moment coefficient, the Magnus moment coefficient, and the pitch damping moment coefficient. All of the above aerodynamic coefficients are necessary inputs to the BRL six-degrees-of-freedom (6-DOF) trajectory program, which completely and accurately accounts for the effect of wind on the trajectory.

The 6-DOF wind study investigated the effect of three wind speeds, and twelve wind directions for each wind speed, for Eley Tenex or R-50 ammunition at a range of 50 meters. The wind directions are on a clock-based system, with the rifleman at the clock center and the target at twelve o'clock. A nine o'clock wind is blowing from left to right across the line of fire; a twelve o'clock wind is blowing from the target toward the shooter.

Figures 6 through 8 illustrate the 6-DOF results, with the standard 50 meter Olympic target drawn to scale, for constant wind speeds of 10 miles per hour (mph), 20 mph, and 30 mph, respectively. The solid black data points represent the impacts of bullets in the wind, if the rifle is properly zeroed at 50 meters range in a no-wind condition, and the rifleman makes no wind corrections. The number adjacent to each impact point is the clock direction from which the wind is blowing. (Note: To convert millimeters to inches, divide millimeters by 25.4).

All three figures exhibit the well-known 10 o'clock/4 o'clock

slant, although for the Eley Tenex or R-50 ammo at 50 meters range, a 9:30/3:30 slant would be more precise. The 10:00/4:00 slant of groups from right-hand twist barrels on windy days has often been observed by benchrest shooters. (Left-hand twist barrels give an 8:00/2:00 slant). Many explanations of this effect have been advanced in the popular literature; most of them are based on misapplications of Bernoulli's law, or the Magnus force.

If Bernoulli's law, or Magnus force, were the cause of slanted groups in the wind, the direction would be reversed; e.g., an 8 o'clock/2 o'clock slant would result from firing a rifle with right-hand twist of rifling. In addition, modern spark-photography range firings have shown that the Magnus force acting on small arms projectiles is too small to have any measurable effect on the trajectory.

The true cause of the 10/4 slant of groups in the wind, from a right-hand twist of rifling, is a phenomenon known to ballisticians as *aerodynamic jump*, which is an effective change in the vertical angle of departure of the trajectory, caused by the initial yaw due to crosswind. The aerodynamic jump due to crosswind can be accurately calculated by means of an equation which will be given later in this article.

Figures 6 through 8 show that the wind response of Eley Tenex and R-50 ammunition is essentially linear in wind speed up to 30 mph; e.g., a 20 mph wind deflects the bullet twice as much as a 10 mph wind, and a 30 mph wind deflects it three times as much as the 10 mph wind. The 1989 study shows that the Eley Tenex and R-50 bullets are slightly more wind sensitive than some previously published .22 caliber wind tables indicate, but the differences are not of any practical significance.

Figure 6 shows that even a 10 mph crosswind, coming from either 2, 3, or 4 o'clock, or from 8, 9, or 10 o'clock, will cause the rifleman to lose one point on the scoring ring unless a verti-

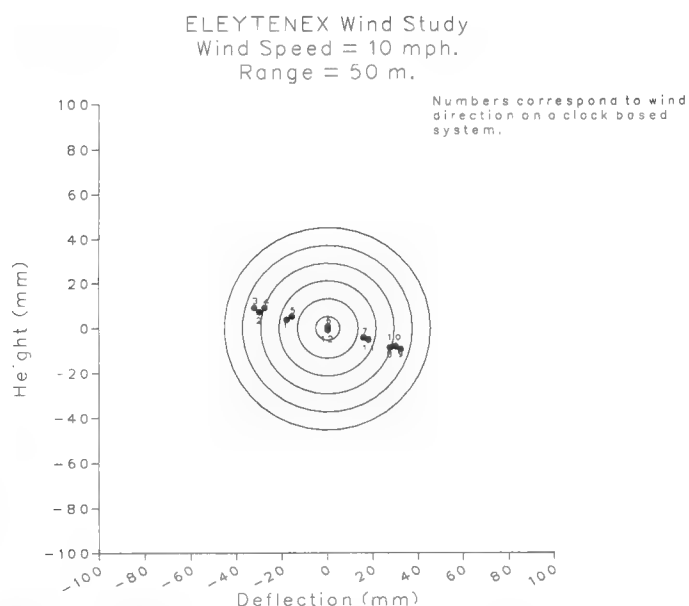


Figure 6. Effect of a 10 mph wind on the Eley Tenex bullet at 50 meters range

ELEYTENEX Wind Study
Wind Speed = 20 mph.
Range = 50 m.

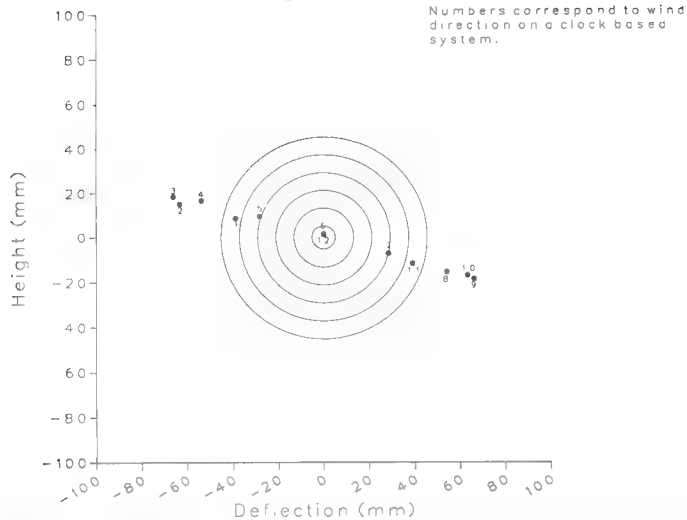


Figure 7. Effect of a 20 mph wind on the Eley Tenex bullet at 50 meters range

ELEYTENEX Wind Study
Wind Speed = 30 mph.
Range = 50 m.

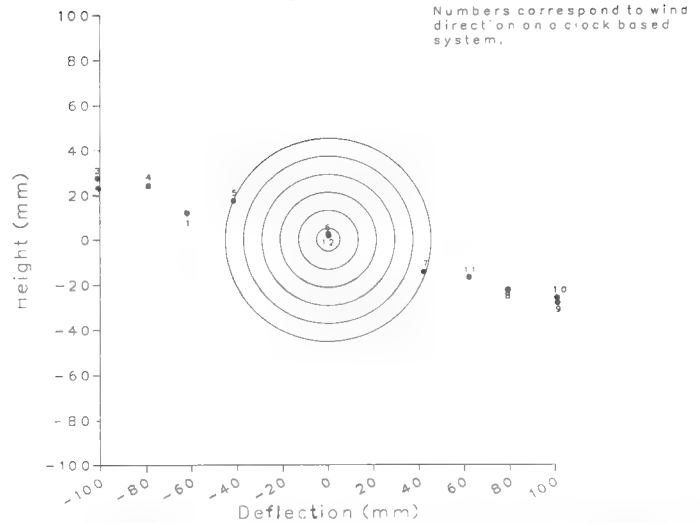


Figure 8. Effect of a 30 mph wind on the Eley Tenex bullet at 50 meters range

cal correction is made in addition to the usual horizontal correction. In a 20 mph crosswind, two points may be lost due to aerodynamic jump, even if the horizontal wind correction is properly made. The ratio of vertical to horizontal correction for the Eley Tenex or R-50 ammunition at 50 meters range is approximately 1:4. If the rifleman needs to move the sight to the left to correct for a wind between 7 o'clock and 11 o'clock, 1 click of elevation should be *added* for each 4 clicks of *left windage* applied. If the sight needs to be moved to the right to correct for wind, 1 click of elevation should be *subtracted* for each 4 clicks of *right windage* applied. (All the above assumes right-hand twist of rifling; the rules for adding or subtracting elevation clicks would be reversed for a left-hand twist barrel).

A very accurate approximation to the results shown in Figures 6 through 8 may be obtained by means of the classical crosswind deflection formula, often called the lag-rule, combined with the vertical deflection caused by aerodynamic jump. These two equations will now be discussed, and a few example calculations will be done, to demonstrate the practicality of the method.

The classical crosswind deflection formula, which has been given in many exterior ballistics textbooks, is well known to most riflemen:

$$(1) \quad D_H = 17.6 W_C \left(T - \frac{R}{V_o} \right)$$

where: D_H = horizontal deflection due to crosswind (inches)
 W_C = crosswind component of wind speed (mph)
 T = time of flight to range R (seconds)
 R = range to target (feet)
 V_o = muzzle velocity (fps)

Note: The factor 17.6 in equation (1) converts the horizontal deflection into the desired units (inches).

The aerodynamic jump due to crosswind acts in the vertical

plane, and modifies the angle of departure of the trajectory. The vertical deflection due to crosswind can be calculated by means of the following formula:

$$(2) \quad D_V = -17.6 \left(\frac{I_x}{w d^2} \right) \left(\frac{C_{L_a}}{C_{M_a}} \right) \left(\frac{2 \pi d}{N} \right) \left(\frac{W_C}{V_o} \right) R$$

where: D_V = vertical deflection due to crosswind (inches)

I_x = projectile axial moment of inertia (#-in²)

w = projectile weight (#) [grains divided by 7000]

d = projectile reference diameter
 (.224" for the present article)

C_{L_a} = aerodynamic lift force coefficient

C_{M_a} = aerodynamic overturning moment coefficient

N = rifling twist rate (inches per turn)

W_C = crosswind component of wind speed (mph)

V_o = muzzle velocity (fps)

R = range to target (feet)

Note that in equation (2), the rifling twist rate, N , is considered positive for right-hand twist, and negative for left-hand twist. A crosswind component blowing from left to right is considered positive; a negative crosswind blows from right to left. On the target, a high impact is considered positive, as is an impact to the right.

Two examples will illustrate the use of equations (1) and (2) in calculating the effect of wind on Eley Tenex or R-50 ammunition. Both examples will be done for 50 meters range, so the calculations may be compared with the 6-DOF results shown in Figures 6 through 8. An ordinary hand-held calculator is all that is needed for these two problems.

Continued on next page

EXTERIOR BALLISTICS AND WIND DRIFT OF CALIBER .22 LONG RIFLE MATCH AMMUNITION

Continued

For a 50 meter distance to the target, $R = 50/.3048 = 164.042$ feet. The muzzle velocity is 1090 fps, and our first example will assume a 10 mph crosswind, from 9:00. The time of flight of Eley Tenex or R-50 ammunition to 50 meters is 0.1575 second. Substituting these values into equation (1):

$$D_H = 17.6 (10) \left(.1575 - \frac{164.042}{1090} \right) = 176 (.1575 - .1505) = 1.23''$$

Some additional quantities are required for calculating the vertical deflection at 50 meters range. The average axial moment of inertia of the Eley Tenex bullet, measured by means of a torsion pendulum, is 0.00003127 #-in², and the average bullet weight is 0.005703 # (39.92 grains). At a muzzle velocity of 1090 fps (Mach No. = .97, at standard sea-level atmospheric conditions), the lift force coefficient, $C_{L_a} = 2.00$, from the spark range firing data, and the overturning moment coefficient, $C_{M_g} = 1.54$, the muzzle velocity, crosswind speed, and the range to the target are the same values used in equation (1). The twist of rifling N, is 16 inches/turn (right-hand twist, so N is positive). Substituting all

the above values into equation (2) gives the vertical deflection of the Eley Tenex bullet at 50 meters range, due to a 10 mph crosswind from 9:00;

$$D_V = -17.6 \left[\frac{.00003127}{.005703(.224)^2} \right] \left(\frac{2.00}{1.54} \right) \left[\frac{6.2832(.224)}{16} \right] \left(\frac{10}{1090} \right) (164.042)$$

Simplifying the above expression gives:

$$D_V = -17.6 [0.1093] (1.2987) [0.0880] (0.009174) (164.042) = -0.33''$$

We find that equation (1) predicts a horizontal deflection of 1.23" to the right, and equation (2) predicts a vertical deflection of -0.33", downward, for a 10 mph crosswind from 9:00. Figure 6, which we will take to be an exact result, shows 1.30" horizontal deflection, and -0.35" vertical deflection, for the same case. The errors resulting from using equations (1) and (2) are negligible.

For a second case, we will assume a 30 mph wind, blowing from 4:00. this direction is 30 degrees away from the 3:00 direction, and we must find the component of the wind parallel to 3:00. The crosswind speed, W_C , for the 4:00 wind is given by:

$$W_C = -30 [\cos (30^\circ)] = -25.98 \text{ mph}$$

Substituting this value of W_C into equations (1) and (2) gives the results below:

$$D_H = 17.6 (-25.98) (.1575 - .1505) = -3.20'' \text{ (to the left)}$$

$$D_V = -17.6 [0.1093] (1.2987) [0.0880] (-0.02383) (164.042) = 0.86'' \text{ (upward)}$$

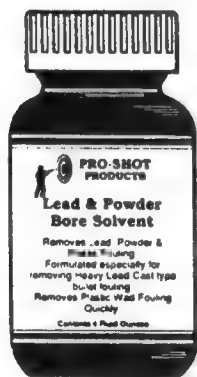
Figure 8 shows that the exact, 6-DOF result for a 30 mph wind from 4:00 is a horizontal deflection of -3.07", to the left, and a vertical deflection of 0.94", upward. Even in a 30 mph wind, the results of equations (1) and (2) are more than sufficiently accurate in practice; the largest error is only 0.13", in the horizontal plane.

Concluding this part of the discussion, we see that the effect of wind on the trajectory of caliber .22 match ammunition at 50 meters range is to cause bullet impacts distributed along a 9:30/3:30 slant line. The horizontal deflection is accurately predicted by the classical wind drift formula, and the vertical deflection is accurately predicted by the ballistic formula for aerodynamic jump. The rifleman needs to make one click adjustment in elevation, for every four clicks made in windage.

Similar calculations can readily be done for other common target ranges, using the values provided in Table 2.

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Table 2

**Time of Flight and Lag Time for Eley Tenex,
with MV = 1090 fps**

Range	Range (Ft.)	T (sec.)	R/V _o (sec.)	[T - R/V _o] (sec.)
50 Meters	164.042	0.1575	0.1505	0.0070
50 Yards	150	0.1435	0.1376	0.0059
100 Yards	300	0.2978	0.2752	0.0226
200 Yards	600	0.6364	0.5505	0.0859

The effect of muzzle velocity on wind deflection of caliber .22 match ammunition was also examined. The fact that high speed .22 Long Rifle ammunition is more wind sensitive than is standard velocity or match ammunition, is widely known to small-bore shooters. Our study not only confirms this effect, but the results can be used to predict the muzzle velocity that would give minimum wind drift for a 40 grain .22 Long Rifle bullet.

The results of the muzzle velocity - wind drift study, for a constant crosswind of 10 mph, blowing from 9:00, at a range of 50 meters, are listed in Table 3.

Table 3

**Effect of Muzzle Velocity on the Wind Drift
of Eley Tenex Ammunition**

Muzzle Velocity (FPS)	Crosswind Deflection (Inches)
850	1.04
900	1.00
950	1.01
1000	1.05
1050	1.09
1090	1.23
1100	1.28

If the muzzle velocity were further increased, the crosswind deflection at 50 meters range would continue to increase, until a muzzle velocity in the neighborhood of 1400 fps was achieved. For even higher muzzle velocities, the wind deflection would begin to decrease, and would continue decreasing with still higher muzzle velocity.

The conclusions of the muzzle velocity - crosswind sensitivity study are that a muzzle velocity in the range of 900 to 950 fps would minimize the wind sensitivity of Eley Tenex and RWS R-50 bullets. The wind sensitivity at a muzzle velocity of 950 fps would be approximately 20 percent less than that experienced at the standard muzzle velocity of 1090 fps. There are no implications here for bullets travelling at supersonic speeds; all bullets fired at high supersonic speeds show decreasing crosswind sensitivity with increasing muzzle velocity.

The fact that the caliber .22 Long Rifle bullet is least sensitive to crosswind at a muzzle velocity around 900-950 fps is not a new result. In 1950, Dr. Charles S. Cummings, 2nd, who was then the head of the Physics Research Department of Remington Arms Company, published a book titled *Everyday Ballistics*. In the 10th chapter of his book, Dr. Cummings presented a result very similar to our modern findings. *You might wonder why none of the major manufacturers developed .22 Long Rifle match ammo with a muzzle velocity around 900-1000 fps. The reason is, no one has been able to get the lower veloci-*

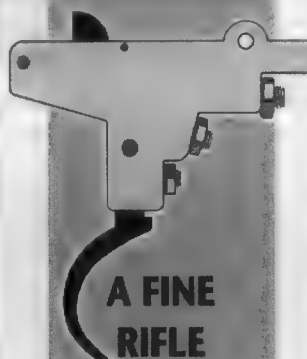
ty ammunition to shoot small groups. Federal Cartridge Company tried it recently, during the Ultra Match ("Gold Medal") R&D project, and they ran into the same problem. It does the rifleman little good to have a bullet that is 20% less sensitive to wind, if it won't shoot!

One last point should be made on the crosswind sensitivity of caliber .22 Long Rifle match ammunition. A study was done to determine the point along the trajectory, between the muzzle of the rifle and the 50 meter target, where the bullet is most sensitive to crosswind. The answer is, the point of maximum sensitivity is just in front of the muzzle, and the sensitivity decreases with increasing range, falling to zero at the target. (*That is a correct statement; crosswind at the target has absolutely no effect on the bullet!*) So the rifleman needs to pay most attention to the closest wind flags, and ignore the far downrange flags. This study was also run for target ranges of 100 and 200 yards, with essentially similar results.

An afterthought: earlier in this article we mentioned the gyroscopic stability factor, but never discussed it, so for those highly technical shooters who are concerned with such matters, a summary of the gyroscopic stability results is included. The spark range measured gyroscopic stability factor of caliber .22 Long Rifle match bullets, fired at 1090 fps muzzle velocity, from rifles with a standard rifling twist rate of 16 inches/turn, at sea-level standard atmospheric conditions, is 1.5. This value is sufficiently high to provide stable flight under all weather conditions, including cold (high air density).

Good Shooting!
Bob McCoy





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THE QUIET RIMFIRE, AND MORE THOUGHTS ON AN ACCURATE 10/22

by
Mark White

Like many of us, I started with a house in the country on five acres, where I built a small range against a steep hillside. Within a few years neighbors had moved in and the area was built up. It wasn't long before the sound of rifle fire brought instant complaints. Even though the range was safe and the backstop secure, neighbors felt uncomfortable with gunfire noise nearby.

I paid a small fortune for a spring powered .17 caliber pellet rifle from Beemans, but the piece simply wasn't accurate, and even the discharge from THAT sent the phone to ringing.

It wasn't long afterwards that I spoke with a writer friend who was also in the business of evaluating and writing about firearm suppressors. He explained that they are legal to own and use in about two-thirds of these United States, and that a private individual could build and own a suppressor if: he applied to BATF for permission, voluntarily got fingerprinted, was checked out by the FBI, and paid a \$200, one-time tax to the U.S. Treasury, the department which regulates NFA (National Firearms Act) firearms.

In Finland the Ministry of Labor and the Ministry of Health are encouraging the widespread use of suppressors on **all** firearms in that country. The two primary objectives: 1. To reduce noise pollution — thus making shooters better neighbors, and 2. To reduce hearing damage and loss (with children and firearms instructors especially at risk. To suppress firearms will encourage their use — thus increasing national proficiency with both rifle and pistol. Finland has been attacked many times. An entire populace skilled in the use of firearms is a powerful deterrent to future aggression.

Throughout Scandinavia and France it is considered simply good manners to fit a suppressor on one's firearm before going out for target practice in one's garden.

Concurrent with my retirement as a college professor, I went by a slightly different route and acquired a license to manufacture, and an **SOT**, (Special Occupational Tax) which grants permission to construct and sell firearm suppressors. For the last few years my main

interest has been accurate .22 rifles, and the devices which reduce their sound level. I have sold quite a number of systems to those who want to shoot quietly, without disturbing their neighbors.

Since the construction and installation of a sound moderator on a rifle usually involves removing the barrel, it should come as no surprise that Ruger's 10/22 and 77/22 (with their easily removed barrels and modular construction) are the standard of the suppressor industry. While I suppress a few of the bolt action 77/22's, the most interest has been shown in the semi-auto 10/22.

I have stumbled across quite a number of things one can do to increase both the reliability and the accuracy of the 10/22 — whether it is suppressed or not.

With regard to reliability, the action of the 10/22 is the first place to start. The blowback bolt, hammer, and recoil spring of the 10/22 are designed to handle the heaviest of the .22 LR rounds, such as the hyper velocity CCI Stingers and Remington Vipers. Those interested in either accuracy or silence will confine themselves to standard velocity or target rounds, which tend to have a muzzle velocity around 1,050 fps. A target round will have a charge of from 1.1 to 1.4 grains of a fairly fast powder, which will quickly obturate the base of a soft lead bullet before moving it gently down the bore. The hyper velocity rounds use up to 3.8 grains of a slower powder, which gives a much more hefty shove against the bolt. The most common high speed (transonic) ammo starts around 1,260 fps, and as it moves down range sheds velocity, passing through the critical sonic level (speed of sound — about 1,100 fps, depending upon atmospheric pressure, temperature and humidity) during which it becomes unstable. As most PS readers know, that is why target velocity .22's are usually kept below 1,040 fps.

Target velocity (subsonic) ammo does not have enough energy to reliably cycle the bolt of a 10/22 rifle when the action gets dirty. When that happens the bolt usually short strokes, and misses picking up the rim of the next cartridge in the magazine. It does not, however, miss the

side of the bullet, which it puts a nasty groove in the side of. If one will commit to using only target grade or subsonic ammo, then the action can be tuned to operate effectively with a more gentle shove. Using such a tuned action with higher powered ammo, however, will be hard on the buffer and the light weight, cast aluminum 10/22 action. If one commits to tuning the action for target ammo, it should be forever married to that type of ammo.

The main obstacle to a full length bolt stroke is the roughness of the upper part of the forward face of the hammer, where it contacts the bolt. I always take the hammer out and hand sand that area using 100 grit paper and longitudinal strokes. Following that, I put the same surface against a cloth buffing wheel charged with green rouge to make it very slick.

I then take the bolt spring guide, and buff the forward portion of the shaft on the same cloth wheel. This must be done while compressing the spring with the bolt handle. If feeding problems still exist, one can remove a few coils from the spring at the rear, by pulling the end of the spring at 90 degrees to the shaft an inch or two, and clipping off the straightened portion. If that isn't enough, then one can bore lightening holes in the rear of the bolt to reduce the reciprocating mass.

While the bolt is out, this would be an excellent time to drill a cleaning hole in the rear of the 10/22's aluminum action. I regard it as a mortal sin to clean a barrel from the muzzle. I have a short section of scrap 10/22 barrel which I can bolt into an action. This goes into the lathe while I center drill the rear end, and then bore it out with a 3/16" or 7/32" bit. In cleaning, I usually put a single moist, 1" round patch on the tip of a 3/16" rod and shove it from the chamber down the bore, and out past the muzzle in a single stroke. The patch is then removed, and the rod carefully withdrawn. This technique must be carefully adhered to in a rifle equipped with a suppressor, as a patch could easily go astray inside the internals. With a properly lapped and polished bore it takes about four patches until they come

out clean — even with the filthy (but accurate and subsonic) Baikal Junior Brass ammo.

For those without a lathe, a 45 degree tip can be ground on the end of a straight piece of 3/16" steel rod (about a dollar at a hardware store). This can be thrust down the barrel and used to mark a centerpoint on the inside of the action, where the cleaning hole should be. The barrel can then be removed, and the hole can be drilled from the inside with a long 3/16" bit.

When reinstalling the barrel, be sure that it is not canted in its socket. Use a feeler gauge between barrel and action on each side of the flat. I use a torque wrench on the two Allen cap screws. I rarely use more than 35 inch pounds, and make sure that both screws are torqued to exactly the same setting. Be careful not to overtighten, as it is easily possible to split the little steel key. With regard to torquing the Allen screws, one can also use a regular Allen wrench (say 4" long) and set the tip of the wrench on a kitchen or spring scale, twisting until about nine pounds (4" X 9 lbs. = 36 inch pounds) appears on the scale. This is known in some trades as a "field expedient".

While the bolt is still out of the action it might be wise to check the firing pin for stroke. Ruger is notorious for short stroking the firing pins on both the 10/22 and the 77/22. This keeps the pins from banging up the barrels when the rifles are dry fired, but often leads to misfires. The 77/22 is a real sinner in this regard. The 77/22 pin (if defective) must be taken out and hammered on radially to make it grow longitudinally. Ordering a new pin won't help, as the new one will likely be as short as the old one. Measure the LOA with a set of calipers, and hammer until the pin has grown about .008" in length. Be careful, don't hammer it crooked.

The 10/22's pin is restrained in its forward motion by a roll pin. Clean the bolt and hold a straight edge against the forward face, bridging the recess for the cartridge head. Hold it up to the light and push the pin forward. The firing pin should go at least halfway towards the straightedge. In no case should the pin actually touch the straightedge, or one runs the risk of denting the barrel. If the forward motion is not sufficient, the roll pin must be driven out to release the firing pin, which is a flat piece of medium hard spring steel stock. To increase the length of the stroke one must file out the REAR of the oval hole in the center of the firing pin with a round needle file. Take about .010" to .012", reassemble, and check to see if the pin now travels far

enough. Don't lose the little firing pin spring, which holds the pin towards the back of the bolt. This part is very important. Sand the firing pin lightly on both sides in a lengthwise direction, and polish lightly on a buffing wheel. Don't sharpen the forward end, or it may start piercing cartridge rims — causing stuck bullets and flying brass fragments. SAAMI specs on the little .22 rimfire bring it close to 20,000 psi, absolute. If the firing pin is worn or broken, order a new one, and a new roll pin from Ruger.

If the hook on the shell extractor is dull, order a new one. There is only one extractor and it must be sharp or it won't work. Sticking a shell in the field will tie the gun up. Most shells can be pulled out with a small screwdriver, but a few must be actually driven out with a cleaning rod. Sometimes a bore brush can be bent and used through the ejection port to clean the chamber. That and a drop of oil will often cure the problem of fired shells that keep sticking.

Once the bolt is stripped it may be lightly smoothed and polished. Curiously, this part is the one most polishing attention is lavished on, even though it will yield the least result. DO NOT polish the front face of the bolt.

Before putting the bolt back in, don't forget to oil the springs, extractor, and firing pin. I use G I weapons oil, with teflon. Shake, before using. Put the action in a padded vise, and use the blade of a screwdriver to push the handle back where it can mate with the recess in the bolt, at which point it will snap into place. This is a job for three hands. Don't use too much oil, as this will encourage the collection of powder residue spewing from the chamber. The amount of residue coming from a suppressed arm is about triple what might be expected, as the can releases pressure over a much longer period.

At this point we're usually ready for some trigger work. (Editor: At this point we are ready to advise you that, from a legal liability viewpoint, neither the author or the publication accepts any responsibility for the reworking of triggers by the reader. Trigger modifications are best left to professional gunsmiths). The 10/22 usually comes with about a 14 pound trigger. I start with the hammer, and reduce the amount of sear engagement by roughly 60%. I do not change the sear angles. If one wants to get fancy it is possible to order or build both an alignment and a stoning jig to ensure that the mating sear surfaces are square and in proper engagement. I usually try for a 36 ounce pull. Any less, and one runs the

risk of full auto fire which will not stop until the magazine is empty. This is both illegal and counterproductive to precision shooting. I also do a butt slam and a safety test to make sure that the hammer will not drop with the safety on, or by itself after the safety is released. The 10/22 cross bolt safety is an excellent one, but it must be allowed sufficient sear engagement in order to work properly.

A setscrew to limit trigger overtravel will do much for accuracy. Another approach is to cut a tiny section of nylon trim cord (from a weed whacker) about 1/16" long. This may be inserted inside the plunger spring for the trigger, and will effectively limit overtravel. This is a cleaner looking solution, but is very tough to fit.

When all is well the action may be reassembled. Don't forget to lube the hammer spring and its plunger. The later 10/22's have a hole for inspection and lubrication of the sear area. The 1/4" bolt buffer pin and the 3/16" trigger block assembly pins are prone to falling out when the action is removed from the stock. A small piece of Scotch tape on one or both sides will prevent that.

There was a time when I thought highly of the factory wood stocks for the 10/22. Then Butler Creek came out with their fixed polymer replacement stock. The Butler Creek stock is usually tight and needs a little scraping for the barreled action to fit properly, but it makes the little 10/22 a far superior package. The nature of the stock material and the tight fit encourages the reciprocating bolt to rebound in such a way that reliability is greatly enhanced. A barreled action that functions poorly will undergo a miraculous transformation when it is inserted into the black Butler Creek stock. There is something about this lightweight plastic stock that improves both reliability and accuracy to a marked degree.

The nature of lubricant on the reciprocating bolt is such that bolt and action bolt moves less at first will increase recoil slightly. This will cause the barrel and the first shot to move up and slightly to the right (for a right handed shooter) of where the rest of the shots will fall. This is called the high first round syndrome, and is peculiar to blowback .22's. This is lessened to a degree with the Butler Creek stock because the nature of the stock encourages the bolt to shear its oily bond earlier in the recoil cycle.

With regard to suppressors, they come in two forms. The first is called an INTEGRAL, where a short barrel is ported (has

Continued on next page

THE QUIET RIMFIRE, AND MORE THOUGHTS ON AN ACCURATE 10/22

Continued

holes drilled near the breech to dump gas early and keep the velocity of high speed ammo below the speed of sound) and where an integral sleeve covers the whole enchilada. Integral suppressors are much more complicated, more expensive, tend to be more quiet, collect more crud, are tougher to clean, and look very much like a bull barrel. At one time all of the suppressors I built for the 10/22 were integral. Then I had a heart to heart talk with my friend the evaluator, who said that there was no point in making a 10/22 suppressor any quieter than the action noise of the firearm. At which point I started to experiment with traditional suppressors called MUZZLE CANS. These resembled American inventor Hiram P. Maxim's original silencers of 1909.

During the last five years there has been a tremendous surge in interest in quiet rifles. Both Remington and Winchester now make subsonic hollow-point .22 LR ammo expressly for use in suppressed arms. While anything under 1,100 fps is usually subsonic, ammo under 1,050 fps is more likely to stay quiet under most atmospheric conditions. The introduction of the inexpensive and accurate Russian Baikal Junior Steel and Junior Brass .22 LR ammo is what really made the simpler and cleaner .22 muzzle can a viable option in the U.S. Junior Brass is the preferred ammunition for the 10/22. Junior Steel cases are tougher to ignite and hard to extract, leading to jams and misfires.

With regard to the 10/22, I started making muzzle cans on an experimental basis about four years ago. Since these devices deal both with expanding gasses and a sound/shock wave from these gasses, there are scientific rules for their construction that defy reason. Why a 1" x 6" can outperforms a similar 1 1/4" x 10" can on a similar barrel is an unknown at this point, but it fortunately allows for a much more compact package. A proper muzzle can on a 10/22 will make the dominant noise of firing that of the bullet striking an earthen backstop. The 10/22 will no longer sound like gunfire noise. In the same vein, an integral can on a bolt action rifle will make the firing pin strike the dominant noise. The report will be barely audible. The bullet flight noise will be a gentle whizzing sound inaudible to most observers.

My experimentation with muzzle cans

brought me into intimate contact with a great many factory 10/22 barrels. Because I had the permits and licensing I could legally shorten barrels below 16" on a registered firearm and play with velocity change, vibration nodes, and test for accuracy trends to my heart's content. The short 16" barrel topped with a permanently mounted 6" can has been an extremely accurate combination. The vibration nodes apparently reach maximum null at this point. I have tried 12", 14" and 18 1/2" barrels, and don't get accuracy results nearly as good. And the 16" barrel with a muzzle can (or a muzzle weight) seems to be extremely stable as well. Not only does it shoot Baikal ammo well, it shoots nearly everything else well.

The 10/22 has a long, sloppy chamber, made necessary by the constraints of a semi auto action and a single extractor. This makes high speed ammo shoot about 75 fps slower than it would coming out of a barrel with a tight chamber. Baikal Jr. Brass ammo exits a 77/22 rifle barrel about 1,050 fps, and a 10/22 barrel about 975 fps.

I took two stock 18 1/2" barrels and chopped them in 2" increments, taking velocity data all the way down to 2". The results, at 78 degrees F:

Barrel	CCI Stinger	Win Wildcat	Rem HV	Baikal Jr. Brass
18 1/2"	1536 fps	1230 fps	1190 fps	972 fps
16"	1539	1232	1194	980
14"	1531	1212	1180	973
12"	1502	1198	1167	955
10"	1464	1176	1150	936
8"	1441	1152	1104	922
6"	1374	1088	1092	854
4"	1236	1004	1020	785
2"	948	794	791	608

For all practical purposes in a .22 rifle, there isn't really much statistical difference between a 12" and a 24" barrel. The same is true with regard to accuracy. The shorter barrel is considerably stiffer, and the time that the bullet is en route is considerably less. In order to be legal, however, most should limit themselves to a 16" barrel. The transfer tax for a short barreled rifle is the same as for a suppressor — \$200.

In cutting a number of 18 1/2" and 20" factory barrels to 16.1", I found a typical increase in accuracy. Whether this was

due to the fact that I carefully recrowned and lapped, or because the stubbier barrels are inherently more accurate, I cannot say. In turning a barrel on a lathe, I have noticed that a slight decrease in length will dramatically increase its resistance to tool chatter and vibration. Longer barrels have much lower frequencies, and they are much easier to bend. They are also subject to vibratory input of fractions or multiples of those frequencies. The more resistance a barrel or a system has to cyclical energy input, the easier it will be to machine, or to shoot accurately. When I started tensioning a barrel in a tube many years ago, it was solely for the purpose of knocking down vibration. But that is another story.

With regard to barrel length, and the greater quantity of escaping gas from a shorter barrel, I would like to mention the simile of a clay extruder die. Those dies used to extrude clay pipe (or bricks with holes in them) have a pin (or pins) loosely hung inside the escape point for the die. The formed material **automatically centers the pin(s)** within the mass of the object being formed. If a barrel's crown is perfectly formed, escaping gas will do the same thing for a bullet. I have been privileged to observe high speed movie

footage of bullets being fired from barrels at one of NASA's labs in Texas. The cameras were focused on the barrel's muzzle, and as I recall .22 LR, .45 ACP, and 30:06 were photographed. It takes from 6 to 30 seconds for the bullet to emerge and disappear from the frame, the size on the screen is quite large, and the photographic quality is excellent. In each sequence a considerable quantity of gas emerges from the muzzle at a high rate of speed, well before a bullet begins to emerge. From the time the bullet begins to show at the muzzle, until it is

clear of the muzzle is perhaps three seconds. The gas that flows by a typical bullet is perhaps 3% to 8% of the total volume. That gas which escapes around a bullet flows straight out of the muzzle, much like a projectile. That gas which exits after the bullet stops quickly at the muzzle and forms a cloud similar to a mushroom, but more squarish in appearance. I had formerly assumed that the gas seal on a bullet was quite good, but since viewing that high speed footage, now know that it is not. I also feel that if the crown is perfect, the escaping gas will help to center an exiting bullet in its barrel.

If I were to order a new, custom barrel for a 10/22 to be used with subsonic ammo it would have a .215 x .221 bore diameter, a 1 in 12 or tighter twist, use a Bentz semi-auto chamber reamer (available from Brownells as a stock item), and be a touch over 16" long.

After fire lapping quite a number of bores I have become a believer in the process. With a new factory barrel I'll fire about ten shots with 800 grit silicon carbide, ten with 800 grit aluminum oxide, and twenty with J.B. Bore paste. NECO sells lapping supplies of finer and coarser grade. The coarse 220 grit should be avoided in the .22 rimfire, although there may be a benefit in the much finer grades, to do smoothing work before the use of J.B. The lapping process gives me a very slick bore that tends to be both consistent and accurate. A new 16" factory barrel fitted with a 1" x 6" can will usually group 1/2" to 5/8" at fifty yards (6 shots Jr. Brass, throwing the first away) using the light Butler Creek stock with a compact 4X scope. A bigger scope, heavier stock, and a better shooter would likely improve that somewhat.

I've had a few used factory barrels which would not perform, and the lapping process just made them worse. Once they're worn beyond a certain point, they're not worth fooling with. One can usually tell how used a barrel is by how badly the breech has been beaten in by the bolt. If the rear face has a surface worn in by over .030" it's usually pretty tired. The bore may be OK, but the chamber and throat have had it. The 10/22 barrel is difficult to set back and rechamber because of the way the barrel retention system is made. I have "fixed" a number of 77/22 barrels by shortening to 17", recrowning, and fire lapping. Usually the last few inches have been ruined by vigorous cleaning from the muzzle. The 77/22 barrel should be inherently more accurate because its chamber is shorter and tighter. Most cartridges have to be

pushed the last 1/8" to chamber them, the bullet already entering the rifling. It is hard to determine just how much fire lapping a barrel should receive. One can shoot groups while lapping, and quit when they start to get worse. Unfortunately, by that time, one has gone too far. With regard to factory barrels, before springing for a new barrel, give the old one a chance to shoot.

I should mention that I have had much better results with blued steel barrels than with stainless. A few .22 stainless barrels shoot very well, but many are just marginal. Blued steel cuts more crisply and is easier to hold tolerances on without galling. Certainly, custom stainless barrels are accurate, but production barrels are not as likely to be.

Before leaving the subject of barrels, it should be mentioned that the so called "muzzle star" occurs on the .22 rimfire because the soft lead bullet begins to strip or deform a bit as it is caused to spin by the rifling. A microscopic examination of .22 bullets captured in snow will show a pressure ridge built up on the driving side of each land, and the grooves in the bullets caused by the lands tend to be wider than those lands. Thus a gap is caused to form on the non-driving side of each land, through which gas and bullet lube escape during the brief ride down the barrel. As the bullet reaches the muzzle these six jets will blow a mixture of molten lube and lead dust across the face of the muzzle, where it will quickly congeal in the symmetrical "star" pattern. The dirtiest portion of any .22 LR barrel will always be the non-driving side of each land, as these six (or 4 or 8) areas are rarely touched by anything except gas. Not even fire lapping will scrub these areas because, as long as the projectile is accelerating, the bullet will be tight against the driving sides of the lands. One reason I prefer a tighter bore and chamber combined with slower ammo is that it encourages less slippage and smaller gaps on the non-driving sides of the lands.

On another subject, the safest way to carry or temporarily disable the 10/22 is to lock the bolt open. A small steel lever forward of the trigger guard accomplishes this. It is difficult to learn to manipulate, but well worth the effort. The 10/22 will not fire with the bolt locked open. Also, if the arm is suppressed, the open bolt allows air circulation to remove water which will condense inside the suppressor. If the arm isn't shooting I always lock the bolt open.

With regard to factory sights, the front

sight on the 10/22 is fair. If the barrel is being shortened and the sight is to be retained I'll turn a 1/2" or 7/16" diameter shoulder at the muzzle. The barrel cutoff with the original front sight can be set in a three jawed chuck, and then bored out and faced off in a lathe. The sight may then be soft soldered or epoxied back in place.

The factory 10/22 rear sight is not adequate. I wish they wouldn't even take the slice out of an otherwise perfectly good barrel so that sight can be driven in. If a scope will not be used a Williams receiver sight (WGRS-RU-22) is usually mounted. One should wait and mount the front sight only after test firing to ensure that all is in proper alignment. I usually tape the front sight in place, test fire, and use a witness mark before epoxying or soldering permanently. Be careful when mounting the barrel in the action, as it is very easily canted, and this may throw the bullet impact off beyond the point where the receiver sight is correctable.

For those using a scope, the flimsy 3/8" dovetail base mount that comes with the 10/22 is inadequate. The slamming of the reciprocating bolt against the steel barrel quickly batters the base loose. I use a 1" Weaver TO9 base in combination with Kwik-Site aluminum rings which are split vertically. I always glue and screw the base to the top of the receiver.

In most cases I've found that the inexpensive Junior Brass is very effective in most 10/22 barrels. Some 10/22's obviously prefer other brands. It is certainly worth the time and effort to experiment. When used in conjunction with the inexpensive muzzle can, high speed ammo is to be avoided. While the discharge noise is relatively low, the sonic boom emanating from a projectile traveling over 1,100 fps is extremely loud. Shooting at an indoor range with a metal backstop will also be quite loud, as the bullet strike against a large piece of metal is at least equal to an unsuppressed discharge.

How effective is the typical suppressor at its intended purpose? Currently I fire from 100 to 150 rounds of .22 LR a day off my back porch. I shoot at both paper and a swinging metal plate 1/2" to 2 1/2" x 4". I do this religiously, every day. Never at night. Since I mounted suppressors on my various target rifles I have not had a single phone call or word of complaint. In fact, one of my neighbors stopped me about a year ago in our local post office and personally thanked me for having "come around" to "our" way of thinking.



SHOOTING FLIES AND BUG HOLES

by

Bill Bartram
Staff Writer

I'd been invited to be the third rider and our destination was the annual warm-up match at the Tacoma Rifle and Revolver Club in Tacoma, WA. Half the fun of any benchrest match is the chatter and offhand conversations with fellow shooters and I wasn't going to miss out on any portion of this aspect.

After signing up, I quickly grabbed my gear out of the pick up, located my bench number and set everything up. I could hear the sounds of happy conversation coming from the loading area, so I gathered the necessary tools and components and headed off in that direction.

Everyone was bemoaning the fact that they weren't at all sure their rifles were ready to compete. No one had touched their gear all winter; the barrels were probably full of spiders or maybe even rusted shut. I just sat there, listening to their stories and watching their noses grow longer and longer.

Much too soon I heard the call to the firing line, so I hurried over, removed the scope cover and lined up the scope on the target. I looked at that target, blinked and looked again. What the heck are we shooting at? It kinda looked like bugs — noooo not bugs — it's flies! Wow, I was about to be involved in the famous Tacoma Rifle and Revolver Club Fly Shoot!

Well, maybe this story is just a touch out of focus, but I didn't exactly buy the spiders in the barrel theory without due suspicion either.

The Tacoma Rifle and Revolver Club has a unique way to get competitors back into the new season of shooting. They hold a very unusual warm-up match. The Club members want everyone to start their benchrest season with a positive attitude and with a smile on their face. They figure that a great way to get the smile started is to shoot flies with your benchrest gun and to do your group-shooting with a handgun.

The Tacoma Rifle and Revolver Club was chartered in 1933, however, the range site has a history of some form of shooting on it for approximately 100 years, making it quite probably the oldest range in Washington State.

The December, 1994, issue of *PRECISION SHOOTING* featured an article, written by Bob Wade, reminiscing about



Manley Oakley, at 79, is still young enough to manage a .338 group with his XP-100.



Ted Larson (left), Allen Bench and Ron Daniels discussing world problems.



Al Sampson (left), Mike Guthrie (left rear), Russ Haydon (left front), Rob Simmons (right rear) and Steve Kostanich (right front) looking over the fine points of a used rifle.

the original fly shoots with the originator, Crawford Hollidge, at his personal shooting range.

Sometime in the early sixties, fly shooting was adapted by the Issaquah, WA, (most city and town names in Washington have Native American origins) range using targets obtained from Crawford Hollidge. When the Issaquah range closed down in about 1988, the tradition of their fly shoot transferred to the Tacoma Rifle and Revolver Club. The handgun group (bug hole) competition transferred to Tacoma at the same time.

The fly shoot had been an established match for some years before the handgun group-shooting came into being. The fly shoot is taken quite seriously by the competitors. They're there to have a pleasant day, to re-establish stories, chat with comrades and to generally enjoy another day of competition. You also have to do some serious shooting just to make sure you don't totally embarrass yourself with your score.

The Tacoma fly shoot is scored a bit differently than reported in Bob Wade's article. Tacoma counts a bullet hole that touches the head of the fly as 5X; touching the front portion of the body (thorax) as 5; rear body shots count 4 points; wing shots are 3; leg shots count as a 2. If the bullet totally misses the poor little critter, the shooter has a decision to make. If the bullet is less than one diameter from any part of the fly, the shooter is given one point for scaring it. If the bullet hole is more than one diameter from the fly, the shooter may elect to take another shot in an attempt to improve his score on that fly. Even with a good scope, it's sometimes difficult to make the judgement. Forgetting to shoot at a fly gives a score of zero.

The square is for sighter shots. The shooter has a time limit of seven minutes to shoot a maximum of eight shots, including his sighter shots. You obviously must be a bit stingy with your sighters early in the target as you may need a second shot on one or two of the flies.

Even though the fly shoot target looks easy, it's the result of a diabolical mind. Each fly is pointed in a different direction, requiring a movement of the rifle position for each shot. In my opinion, holding off on the aim point is more difficult on fly shooting than for either Hunter Rifle or group-shooting. The body location changes position around the head of the fly on each shot. Example: A bullet hole slightly high and right on the 4 o'clock fly will still hit the front body for 5 points. That same hit on the 8 o'clock fly will be a clean miss.

Anyone who manages a 25 5X score on a target has earned respect. He has done an outstanding job of shooting. The head measures about .075 x .125; thorax is about .100 x .100; rear body is .250 x .230; front to rear legs is .750; wing edge to wing edge is .750. The worst case scenario for a 25 5X score is a five shot group less than .318, center to center, on

a target that is constantly shifting location.

Jim Folwell runs a good match, making sure that all shooters, whether new or experienced, feel comfortable and are enjoying themselves. It's a class act in every respect. Every shooter present seems to be willing to help out the newer

Continued on next page



Wally Siebert nailed his share of those pesky flies today, also.



Allen Bench taking great pains to point out a missed fly. Thanks a lot, Allen. That's my target.



This is how a small group handgun looks. With Ron Daniels behind the steering wheel it managed a .095 five shot group.

SHOOTING FLIES AND BUG HOLES

Continued

shooters. Within minutes of driving in the gate, the new shooter feels welcome.

Three of us travelled together across the mountains to attend the fly and bug holes shoot, leaving town at 3:30 AM in order to be on the firing line at 9:00 AM. This included a twenty minute McMuffin and coffee stop. Of the three, I had, by far, the most experience in benchrest shooting. I had shot one official Hunter Rifle match plus three more targets at a fun match. Al Sampson had shot only 3 targets in his vast career of benchrest, but we could both lord it over Mike Guthrie because he'd never ever taken a shot at a benchrest target of any kind.

We had two other competitors from our Club at the Tacoma fly match; Allen Bench, who has been at the game for many years and Rob Simmons, another experienced three target shooter, who would compete with a rifle borrowed from Allen.

Al Sampson and I had both competed for years in handgun metallic silhouette shooting, I've been interested in long guns for only the past year or so. Prior to that I'd always thought that a rifle was nothing more than an XP-100 that had been ruined. Allen Bench has kinda been adjusting my attitude in that respect lately.

Al Sampson and I felt just a tiny bit smug on the way to Tacoma. At least we had somewhat reasonable equipment with which to compete. We'd both purchased used 6mm heavy varmint rifles that shoot reasonably well. Mike brought his best rifle also, a break open Contender in a rifle stock with a 221 Fireball barrel by Bullberry.

There were some easily recognizable names trying to head shoot paper flies. Ted Larson, Allen Bench, Wally Siebert and Manley Oakley come instantly to mind. The combined weight of bullets these gentlemen have shot downrange over their shooting careers, would undoubtedly flatten the tires on my pickup.

Shooting conditions were pretty typical (or so I'm told) for the coast of Washington in the spring. The shooting

god decreed that we should have some rain, some sunshine and some gusting winds (up to 15 mph or so) at what seemed to be several directions at once. Oh yeah, it was cold, too.

I'm the first to admit that I haven't learned much about reading and compensating for wind conditions yet, but obviously some of the shooters do. There were some impressive scores shot for the conditions.

A perfect target would be scored as a 25 5X; a five target aggregate potential of 125 25X. Steve Kostanich narrowly won the fly shoot with an aggregate of 120 10X, with Ted Larson pushing Steve hard with an aggregate of 119 14X.

Remember my riding companion, Mike Guthrie, and his Contender rifle? His gun and equipment were outclassed, but his shooting ability was not. He came in only ten points behind Al and me. Manley Oakley was seen spending a considerable amount of his spare time looking that Contender over and scratching his head. Obviously a Contender with a 12 power heavy duplex scope just wasn't supposed to shoot that well.

I've been told that there are two basics to truly learn before you can hope to do well in the fly shoot. The first is to know your bench gun really well and learn exactly what you can expect it to do. The second thing is to stay alert to what the wind is trying to tell you. They say that if you tune up your hearing aids just right, you can actually hear the voice of the wind. If you listen closely it can give you

subtle messages. Messages like "Aim half a bullet hole to the left and a quarter hole high." It's all true. That day I heard my very first wind message. It said "Gooooo hooooome. Gooo hooooome."

Only a whisper and a jump back in time, prior to the invention of electronics, calculators and computers, group shooting scores had to be done by pencil and old fashioned arithmetic. At a large match the postings for the results could take quite a while.

In late 1963 at Issaquah, while waiting for the scores, one of the competitors brought out a new toy. A Remington XP-100 in 221 Fireball. He set it up utilizing his front rest and bag and started shooting groups with it. Within a few months serious group-shooting was being done with handguns while waiting for the rifle scores to be posted.

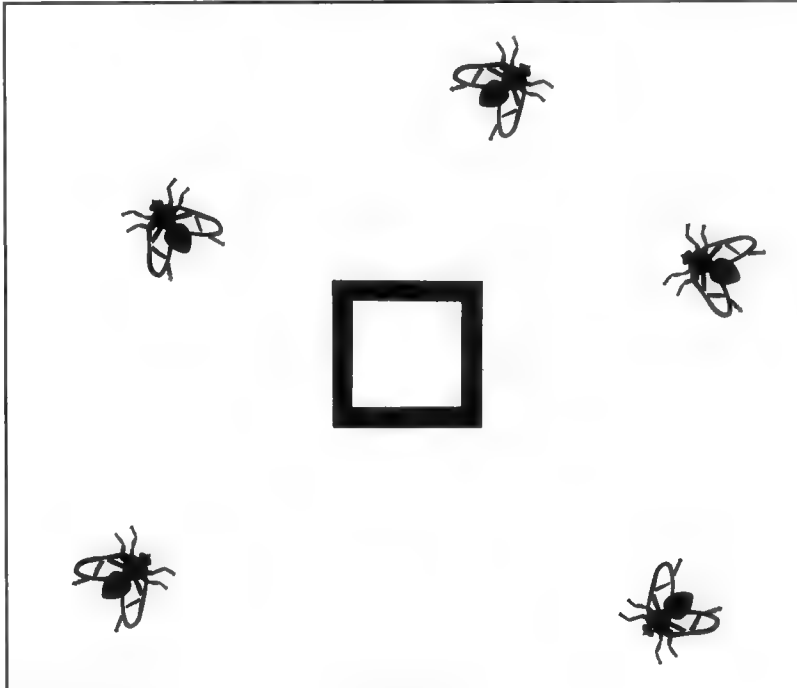
Handgun group-shooting (bug hole) is conducted on a Hunter Rifle target; a five shot group on each of the five normal targets. Two sighter targets are provided. A total of forty minutes is allowed to complete all shooting. The handguns must be centergrip; any scope and rests can be used.

Steve Kostanich won the match with a 5 group aggregate of .4302 with Ron Daniels in second place with a .5212 aggregate. The record aggregate is .389. One absolutely outstanding group was shot by Ron Daniels — a .095 — with a handgun. I don't know if anyone has ever bothered to keep track of official group records (100 yards) for handguns, but it

might just be that this is a record or at least very close to it.

I shot in the handgun group-shoot with a borrowed XP-100 in 221 Fireball. I managed two groups in the mid fives to low sixes, but also three groups over one inch. In truth, other competitors shot the bug hole size groups. One of mine was about the size of a small rat hole.

The four hour drive home seemed to be only minutes for three guys who had had a great time, as each of us had to relate our own particular story to the other two, shot by shot. We're hooked!

		
COMPETITOR	MATCH NO.	SCORE



ESTIMATING VELOCITIES REVISITED

by
Don Miller

Mathematics often turns off a lot of us, whose skills lie elsewhere. But to really estimate interesting ballistic quantities, we can't avoid some relatively simple mathematics. The symbols actually make it easier for some of us to see the relationships. Besides, once we get to the "bottom line," we don't have to worry about all the technical arguments or intermediate equations. We can just substitute numbers into the final results, as I will show by some examples. All we need is a hand calculator with a square root key. Now to business.

The purpose of this article is to explore ways of estimating velocities from cartridge and gun data without using a chronograph. Some are old and others are new. At the end we will recommend a couple of formulas. One is very simple and needs only the powder charge and bullet weight (eq. 7); the other also needs the expansion ratio (eq. 18). Again you just need to plug in the numbers. We will find that despite the complicated things that go on in small guns, these rules give reasonably good results from the .17 Remington to the 16" cannon. They work only if all the powder is burned inside the gun.

A recent article in Precision Shooting (August 1991, pp 48-49), entitled "Estimating Wildcat Velocities", was based on the idea of gun efficiency and its connection to muzzle velocity and powder charge. The *ballistic efficiency* of the gun e is the ratio of the muzzle energy $mv^2/(2g)$ to the total energy contained in the powder charge Kc .

The symbols are m the weight of the bullet in grains, c the weight of the powder charge in grains, v the velocity in ft/sec, g the acceleration due to gravity (32.2 ft/sec²), and K the energy content of the powder in ft lbs/grain. The energy content K has the approximate value 175 ft lbs/grain for single base powders (like the IMR series) and 215 ft lbs/grain for double base powders (like Hercules 2400).

When the appropriate conversion of grains to lbs is done (7000 grains/lb), the ballistic efficiency is given by

$$e = \left(\frac{mv^2}{2 \times 7000g} \right) / (Kc) \quad (1)$$

This can be solved for the velocity v . With the constants evaluated, we get

$$v = 671.4 \sqrt{K(c/m)e} = 671.4 \sqrt{K \epsilon e} \quad \text{General Case (2)}$$

$$v = 8882\sqrt{\epsilon e} \quad \text{Single Base (3)}$$

$$v = 9845\sqrt{\epsilon e} \quad \text{Double Base (4)}$$

where the Greek letter ϵ (epsilon) stands for c/m , which is often called the *mass ratio*. The mass ratio is one of the principal quantities of interior ballistics.

What good is this formula if you don't know the efficiency? Well, about 100 years ago, Karl Crazz (a famous German ballisticsian of the early part of this century) found that the efficiency of guns using smokeless powder is about 0.3, i.e., 30% [ref. 1]. The same is approximately true for modern guns [ref. 2-5]. Therefore let's try $e=0.3$. With the above values for K for single and double base powders, eq. 2 gives neat, simple formulas for the velocity in terms of $\epsilon=c/m$

$$v = 4865\sqrt{(c/m)} = 4865\sqrt{\epsilon} \quad \text{Single Base (5)}$$

$$v = 5392\sqrt{(c/m)} = 5392\sqrt{\epsilon} \quad \text{Double Base (6)}$$

The most interesting thing about these results is that they are already nearly 50 years old. Exactly this same argument was used by Commander A. P. Webster in an American Rifleman article [ref. 6]. He found the value of the constant for all powders in eq. 2 was 4850, very close to the one we just found in eq. 5! Consequently this result has justifiably been called Webster's Rule. It is surprisingly good for a simple quick and dirty estimate, provided all the powder is burned in the gun. Typically the estimated velocities are within 100-200 ft/sec, and all you have to know is the mass ratio ϵ , the weight of the powder divided by the weight of the bullet (c/m). If the calculated value is much larger than a chronographed value, then probably the

powder is not all burned in the gun. For this equation, the maximum errors are 250-400 ft/sec.

What is even more interesting is that the idea of the velocity v being proportional to the square root of $\epsilon=c/m$ actually goes back 200 years. It was proposed by Charles Hutton in the 1790's for black powder cannons, based on his extensive experiments using a ballistic pendulum. In the last century it was called "Hutton's Rule."

Here is an example using old data for the .243 Win. from the 1969 NRA Handloader's Guide [ref. 7]. The powder charge c was 38 grains of IMR 3031, and the bullet weight m was 75 grains. Then $\epsilon = c/m = 38/75 = 0.5067$, and $v = 4865\sqrt{0.5067} = 4865 \times 0.7118 = 3463$ ft/sec. The chronographed value was 3417 ft/sec. Our estimate is 48 ft/sec too high, but this is quite close for such a crude estimate.

Even if all the powder is burnt in the gun, there are inevitable errors involved in these velocity estimates. These are due to tighter or looser than usual bores, throats, or crimps; hotter or cooler primers; different bullet or jacket hardness; or non-uniformity of grain size of the powders; etc. These affect the efficiency too. In fact, in a set of 121 selected cases of IMR data [ref. 7], where the powder was all burned in the gun, the efficiency values vary from 0.24 to 0.38.

Several years ago, I analyzed a larger set of selected data for IMR powders (single base), where "all burnt" was in the gun (164 examples). I noticed that a slightly more complicated equation gave a better correlation of v with ϵ . This equation can be written

$$v = 5975\sqrt{\epsilon(1-0.3\sqrt{\epsilon})} \quad (7)$$

For this data set, the errors are typically 100-150 ft/sec, and the maximums are about 200 ft/sec. On the average, this is better than Webster's Rule. It too gives a simple quick and dirty estimate of velocity, and still depends *only* on the mass ratio c/m . It (as well as Webster's Rule) allows a rapid approximate look at the effect of small changes of powder charge

Continued on next page

ESTIMATING VELOCITIES

Continued

and/or bullet weight. Here is an example, using the same .243 Win data used above. We have $\epsilon=0.5067$, so $\sqrt{\epsilon}=0.7118$. Then eq. 7 gives $v = 5975 \times 0.7118 (1 - 0.3 \times 0.7118) 3345$ ft/sec. This is 72 ft/sec low, but is also close.

Now everyone knows that higher velocities are obtained from longer barrels with the same value of c and m (except for very long barreled .22s). Therefore the efficiency must be higher for these cases. Similarly, the extra term involving ϵ in eq. 7 says there must be some further correlation of e with ϵ as well. These were not taken into account in Webster's equation and only partially taken into account in eq. 7. Therefore there must be other parameters involved.

In this circumstance, the author of the 1991 article did suggest a possible advance. He proposed that the efficiency could be correlated with another interior ballistic parameter, which we will call a . His parameter is

$$a = \frac{c/V}{m/d^2} = \frac{\epsilon d^2}{V} \quad (8)$$

where V is the total volume of the gun (i.e., bore plus chamber) in cubic inches, d is the diameter of the bore in inches (m/d^2 is the sectional density). The volume does involve the barrel length, and $\epsilon=c/m$ can also be seen in eq. 8. The quantity a is not dimensionless; its units are "per inch."

Unfortunately he did not provide any correlation or method for getting e from a . He just said "have fun." Of course, without some such correlation, his idea isn't much help. However, using the data mentioned above for the 121 selected cases with IMR powders, we can search for a correlation.

Figure 1 shows e (from eq. 1) plotted against a , where a was calculated by the methods described below. Sure enough, there is a more or less straight line which declines as a increases. There is a lot of scatter, but less than if we just took the average of $e=0.3$. The decline means that the smaller the value of a , the larger the efficiency e . For example, since the volume V is roughly proportional to the barrel length, a longer barrel gives a smaller value of a , and therefore a larger efficiency, just as we would guess. A smaller value of ϵ corresponds to complete burning farther back in the gun, giving the pressure more time to act on the bullet. This also gives a smaller a and thus a larger efficiency.

The dotted straight line in Figure 1 is obtained by a least squares fit to the 121 selected data points. (These were also chosen because they have all the data necessary to calculate a). This line is

$$e = 0.377 - 4.14a = 0.377(1 - 10.98a) \quad (9)$$

However, to take advantage of this correlation, we have to be able to calculate a . To get a , we have to find the volume of the gun V . This can be done in more than one way. (The reasons for using different ways will be seen later.)

First, V is related to the *expansion ratio* R (a dimensionless quantity). The expansion ratio is the volume of the gun V divided by the volume of the case behind the bullet S . Since S is in grains of water, we get V in cubic inches by the simple equation

$$V = \frac{RS}{252.4} \quad (10)$$

where the 252.4 (grains of water)/inch³ is the conversion factor which converts S to cubic inches at 70 degrees F.

The expansion ratio R is also an important interior ballistic quantity, and is related to S and the bullet travel l by the following well-known equation:

$$R = 1 + \frac{252.4 \left(\frac{\pi}{4} l d^2 \right)}{S} = 1 + \frac{198.22 l d^2}{S} \quad (11)$$

where $(\pi/4)l d^2$ is the formula for the volume of a cylinder of length l and diameter d , and where the 198.22 is for 70 degrees F and is just the conversion factor $(\pi/4) \times 252.4$. Obviously bullet travel l , R , and V are closely related.

The second way to get V is in terms of an "effective length" of the gun l^* in inches as

$$V = \frac{\pi}{4} l^* d^2 \quad (12)$$

This is what the barrel length would measure if the cartridge case had its proper volume, but the same inside diameter as the bore. Now l^* can be found from the bullet travel l (from the base of the seated bullet to the muzzle in inches) and from the "effective length" of the case l_c^* in inches. This l_c^* is in turn obtained from S in grains of water by

$$l_c^* = \frac{4}{\pi d^2} \frac{S}{252.4} = \frac{S}{198.22 d^2} \quad (13)$$

This gives l^* as

$$l^* = l + l_c^* = l + \frac{S}{198.22 d^2} \quad (14)$$

From these various ways of writing V , we get the same numerical value of a

from these different looking but completely equivalent forms:

$$a = \frac{\epsilon d^2}{V} = \frac{252.4 \epsilon d^2}{RS} = \frac{4 \epsilon}{\pi l^*} \quad (15)$$

(For ballistics aficionados, a is also $252.4 \Delta d^2 / (mR)$, where the Greek letter Δ (delta) stands for the *loading density* c/S .)

How do we get the data to actually do the calculations? Of course c and m are easy, since they are what we would consider exploring for with our gun (starting with loading tables of course, to be safe.) These give us ϵ . If we actually have the gun, cartridge cases, and bullets, then it is an easy measurement to get the bullet travel l , as described by Bill Davis' excellent article "Some Simplified Interior Ballistics for Handloaders" in the 1986 edition of *Handloading* [ref. 8(a)]. The value of S is obtained by weighing the case empty and full of water, also as described in Bill Davis' article. The difference is the volume of the whole case in grains of water, and S is that volume less the volume displaced by the seated bullet. The bore diameter d comes from the gun itself. Now we have enough to get l^* from l and S by eq. 14. From these, we can get a .

Here is our .243 Win example again, this time using our new correlation of e with a . Some years ago, using the techniques described above, I obtained values of $l=24.2$ inches and $S=51.43$ grains of water from overall cartridge length, bullet length, and the capacity of the .243 Win case in grains of water. Together with $d=0.243$, we obtain $R=6.51$ from eq. 11. Then eq. 15 gives $a = 252.4 \times 0.5067 \times 0.243^2 / (6.51 \times 51.43) = 0.02256$, and the correlation of eq. 6 gives $e = 0.377 - 4.14 \times 0.02256 = 0.2836$ (28.36%). Therefore eq. 2 (with $K=175$) gives us $v = 8882 \sqrt{0.5067 \times 0.2836} = 8882 \sqrt{0.1437} = 3367$ ft/sec. This value of v is 50 ft/sec low, and is also close to the chronographed value 3417 ft/sec.

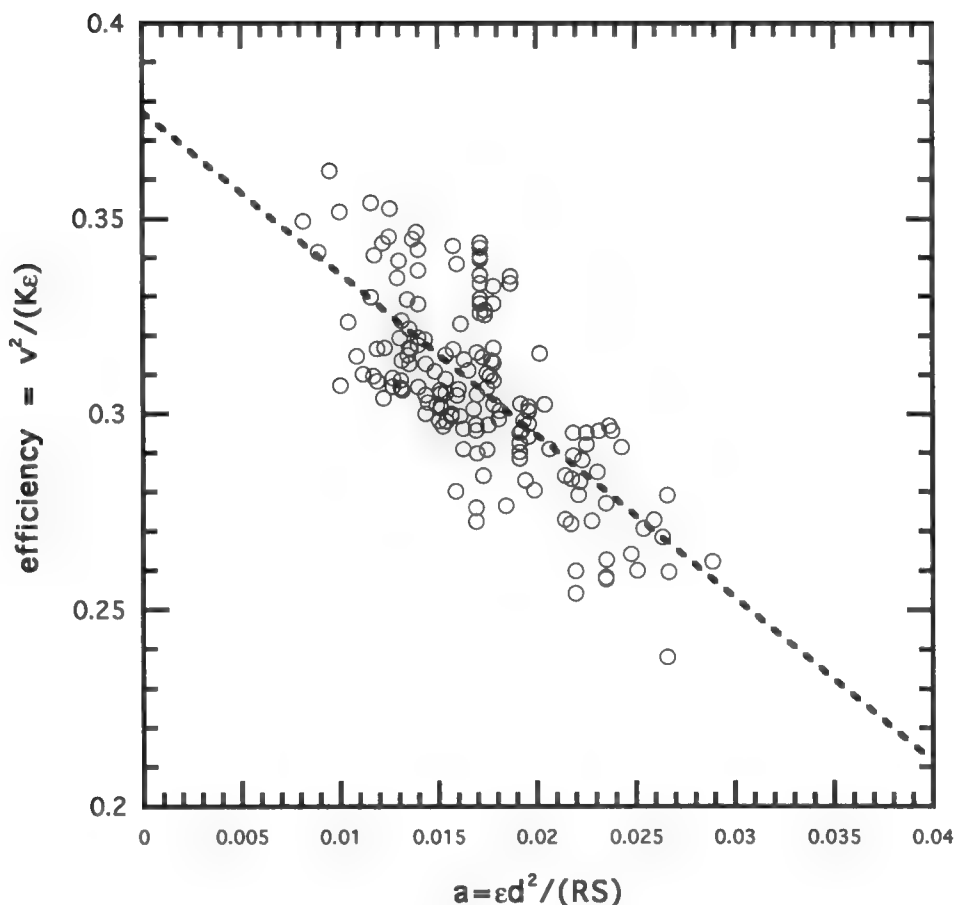
But what if we don't have the gun, cases, bullets, etc. on hand? How can we estimate velocities using this new a correlation? Don't despair, since there are some approximations for the various pieces of a which are not too bad.

The average value of case volume for many common cartridges is given in Bill Davis' article mentioned before [ref. 8(b)]. Seating depths depend on the bullets used, but unfortunately most tabulated data do not contain that information. However, they do typically range from 0.5 to 1.5 calibers. Therefore a reasonable approximation is to assume that the

Figure 1

e vs a

file a3



seating depth is 1 caliber. (The error gets larger as the caliber gets larger.) In that case, the volume of occupied by the bullet in the case is just $(\pi/4)d^3$ cubic inches, with a negligible correction for boat-tailed bullets. To get this volume in grains of water, we simply use $198.22d^3$. For our .243 Win example, Bill Davis lists 54 grains of water for the whole case. Then our estimate of S is $54 - 198.22 \times 0.243^3 = 51.16$, compared to our measured value of 51.43. This is plenty close enough, because the internal volume of cartridge cases depends on the manufacturer and on the size of the chamber of the particular gun to be used. These factors can cause variations of up to 10%, i.e., from 1 to 7 or 8 grains of water. This means one decimal place is more than enough.

Here comes the reason for the second way of getting the gun volume V by means of l^* . There are crude but easy approximations to get l^* as follows.

One way is to calculate the effective length of the cartridge case l^* for our 121 cases where S is known. The values turn out to vary from 2.5 to 4.5, with an aver-

age of 3.5 inches. This deviation from the average of only an inch is fairly small with respect to bullet travels of 20–30 inches. Therefore a reasonable estimate of l^* is $l^* = l + 3.5$.

Here is a second way to estimate l^* . We can ask what is the average difference between the barrel length l_b and bullet travel l . That turns out to be about 2 inches for most calibers, so that $l = l_b - 2$. Then using the result in the previous paragraph, $l^* = l + 3.5 = (l_b - 2) + 3.5 = l_b + 1.5$. This estimate is useful when l_b is known and l is not. This estimate may actually be better than $l + 3.5$, because of compensations. It is the easiest way to get l^* from the limited data tables, and thus a value of a . This estimate can be used in the a rule (eq. 9) when the barrel length is given.

What happens in our .243 Win example if we use our approximate values for l^* ? For the case of $(l + 3.5)$, we get $a = 4\epsilon/(\pi l^*) = 4 \times 0.5067 / (3.1416 \times (24.2 + 3.5)) = 0.02329$, $e = .377 - 4.14 \times 0.02329 = 0.2806$ (28.06%), so $v = 8882 \sqrt{0.5067 \times 0.2806} = 3349$ ft/sec. For this example, $l_b = 26$ inches, so our second estimate for

a is now $4 \times 0.5067 / (3.1416 \times (26 + 1.5)) = 0.02346$, $e = .377 - 4.14 \times 0.02346 = 0.2799$ (27.99%), so $v = 8882 \sqrt{0.5067 \times 0.2799} = 3345$ ft/sec. Both of these estimates from estimated l^* are close to each other, and are about 70 ft/sec low. They are about 20 ft/sec lower than the value gotten from the correct value of a , but all three give acceptable estimates of v .

The use of a to improve the velocity estimate is a reasonably good idea. Are there any other related parameters that could characterize e ? The expansion ratio R is also an important measure of "effective length." Therefore, a reasonable choice might be ϵ/R instead of ϵ/l^* , since both ϵ and R are dimensionless quantities. Figure 2 shows a plot of e vs ϵ/R . This too is more or less a straight line, with slightly less scatter than e vs a . The least-squares fit of the 121 selected IMR points gives

$$e = 0.352 - 0.930 \frac{\epsilon}{R} = 0.352 \left(1 - 2.642 \frac{\epsilon}{R} \right) \quad (16)$$

Once again, our .243 Win example gives $e = 0.352 - 0.930 \times 0.5067 / 6.51 = 0.2796$ (27.96%), so $v = 8882 \sqrt{0.5067 \times 0.2796} = 3343$ ft/sec. This is 74 ft/sec low, and is much the same as for the estimates using a .

What we usually want are direct calculations of velocity v , rather than the ballistic efficiency e . Therefore we can substitute the various correlations for e into eq. 3 and collect the constants. We summarize the results below, and include Webster's, Miller's ϵ , and Bill Davis' adaptation of an equation of Powley. This velocity equation is cited in Davis's article [ref. 8(c)], and has been transformed into our notation. Remembering that ϵ is (c/m) , we have

$$v = 4865 \sqrt{\epsilon} \quad \text{Webster Rule} \quad (5)$$

$$v = 5975 \sqrt{\epsilon} (1 - 0.3 \sqrt{\epsilon}) \quad \text{Miller } \epsilon \text{ Rule} \quad (7)$$

$$v = 5454 \sqrt{\epsilon (1 - 10.98a)} \quad a \text{ Rule (from eq. 9)} \quad (17a)$$

$$v = 5454 \sqrt{\epsilon \left(1 - 13.98 \frac{\epsilon}{l^*} \right)} \quad a \text{ Rule using } \epsilon/l^* \quad (17b)$$

$$v = 5270 \sqrt{\epsilon \left(1 - 2.642 \frac{\epsilon}{R} \right)} \quad \text{Miller } \epsilon/R \text{ Rule (from eq. 16)} \quad (18)$$

$$v = 8000 \sqrt{\frac{\epsilon}{1 + \epsilon/3} \left(1 - \frac{1}{R^{1/4}} \right)} \quad \text{Davis} \quad (19)$$

Continued on next page

ESTIMATING VELOCITIES

Continued

These are all for IMR or single base powders. These equations should also give a fairly good result for double base powders if the calculated velocity is increased by about 10%.

We have now examined a number of related ways to estimate the velocity, as a means to explore load development. All have given much the same results for the .243 Win example. What about some other examples?

In Table 1 are several other results for other standard guns, chosen to give various c/m , calibers, velocities, and expansion ratios. Generally all but the Webster and Davis equations give reasonably good results, within about 100 ft/sec. This is not bad for cold turkey estimates. In particular, the values from the correct a and the two l^* estimates ($l+3.5$) and ($l+1.5$) are all within 20 ft/sec of each other and about 40 ft/sec from the Miller ϵ Rule. Even Webster's is not all that bad. The worst case is the .30-30, where the closest results are about 150 ft/sec high. In this case, we might guess that not all the powder is burned in the gun.

For these standard guns, the idea of correlating efficiency with a has actually led to some improvement over Webster's simple rule. The ϵ/R , an idea suggested by the a concept, brings a similar improvement. The simplest reasonably accurate estimates, requiring the least amount of data, are the Miller ϵ Rule and the a rule using ($l+1.5$).

Our results are based on fitting equations to a limited data set. More complete data sets may have slightly different numerical constants in the equations, so our results are preliminary. However, they won't be much different even with a larger data base.

With this in mind, let's consider two less standard guns: the .17 Remington and the 16" cannon.

Ref. 9 has data for the .17 Remington for c , m , v , d , and l ($=24"$). The case is about 1.8" long, and the seating depth is guessed to be about 0.17". Therefore an l about ($l-1.63$)= $22.37"$ should be reasonably close. Ref. 8(b) gives the case volume as 26 grains of water, which with the estimated seating depth gives $S=25.03$, $R=6.249$, and $a=0.04303$.

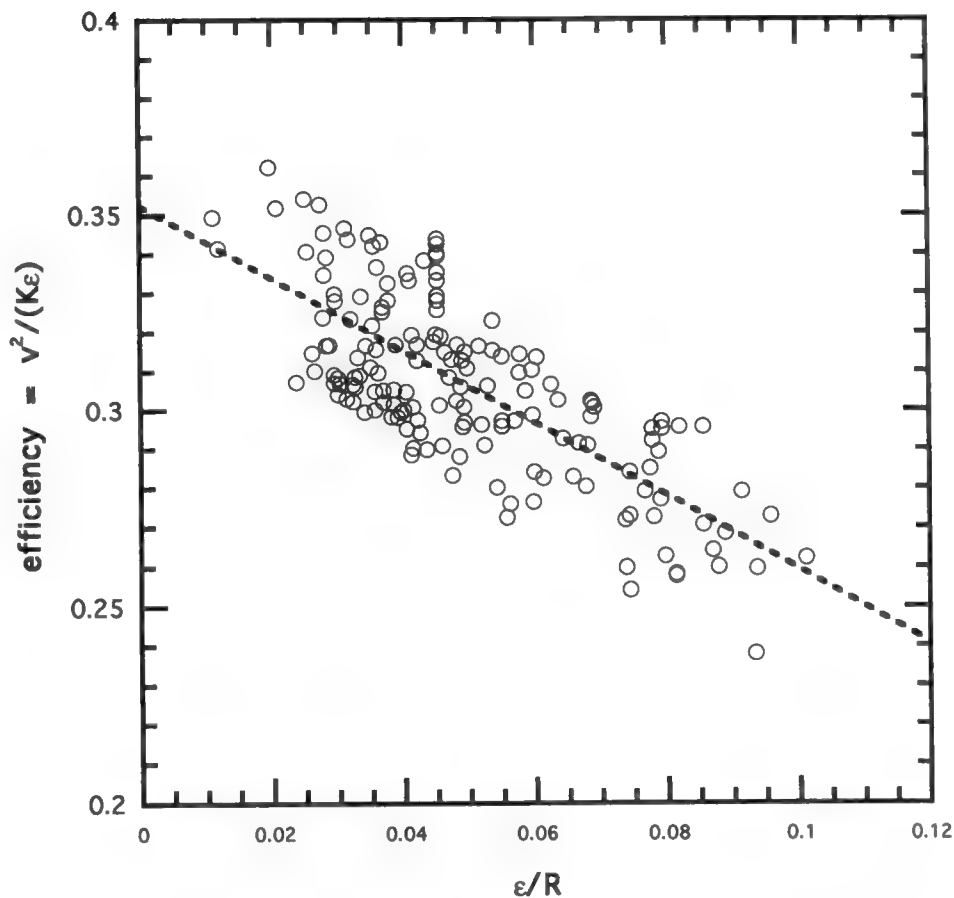
Ref. 10 has data for the armor piercing shell of the 16" cannon. These data are all given in inch and lb units, so no conversion factors from grains of water to cubic inches are needed. We find that $\epsilon=0.2407$ and $R=6.136$. These are very

similar to standard guns, and shows that the 16" cannon can be considered as just a giant scaled-up standard rifle. However, the very small value of $a=0.000372$ implies an unrealistically high efficiency.

The data and results are in Table 2. The Webster and a rules don't work very well for these two cases, and Davis' is good for the .17 Remington but poor for the cannon. On the other hand, the Miller ϵ and ϵ/R rules are significantly better than the others and work well in both cases. The a rules fail for the cannon because a is a "per inch" quantity, whose correlation for small guns (20-30" long) has been extrapolated to a gun 800" long. However, the ϵ and R values for the 16" cannon fall within the same ranges as small caliber rifles. Consequently it is not surprising that the ϵ and ϵ/R rules give reasonably good results. The comparisons in Tables 1 and 2 show that the Miller ϵ (eq. 7) and ϵ/R (eq. 18) rules give the best overall results, partly because they involve only dimensionless quanti-

Figure 2
 ϵ vs ϵ/R

file a3



ties. The easiest is the ϵ rule, because R is not always as easy to obtain or estimate.

We note in passing that there is another kind of efficiency, called the *piezometric* efficiency. High piezometric efficiency requires large values of c/m and slow powders to keep the pressures at a reasonable level. This situation has burnt near or even beyond the muzzle (i.e., spitting powder), resulting in higher velocity for a given powder charge and pressure, but increasing the muzzle blast and the spread of velocities from shot to shot.

In contrast, the *ballistic* efficiency we have been considering in this article is improved with faster powders which are burnt much earlier in the gun and have lower values of c/m for reasonable pressures. In this situation, more uniform velocities at the muzzle are obtained with burnt farther back in the gun. In principle, therefore, higher ballistic efficiency should give better accuracy for precision shooting, with perhaps lower velocities.

Table 1. Data for Various Calibers

Case	.243 Win	.30-30	.30-06	.35 Rem	.375H&H	.45-70
<i>c</i>	38	35	47	28.5	77.5	53
<i>m</i>	75	150	180	200	300	405
<i>l</i>	24.2	22.5	22.0	20.4	22.6	20.4
<i>d</i>	.243	.308	.308	.3585	.375	.457
<i>S</i>	51.43	36.69	60.10	44.10	76.70	60.89
ϵ	0.5067	0.2333	0.2611	0.1425	0.2583	0.1309
<i>R</i>	6.51	12.53	7.90	12.82	9.23	14.93
<i>l_b</i>	26	24	24	22	24.94	22
Powder	IMR	IMR	IMR	IMR	IMR	IMR
	3031	4320	4064	4198	4350	3031
measured <i>v</i>	3417	2315	2542	1982	2612	1827
Webster eq.3	3463	2349	2486	1836	2473	1759
Miller ϵ eq.5	3345	2467	2585	2000	2567	1927
<i>a</i> eq.17	3367	2452	2578	1964	2573	1889
<i>l</i> +3.5 eq.17	3349	2464	2580	1971	2572	1895
<i>l_b</i> +1.5 eq.17	3345	2460	2580	1969	2575	1894
Miller ϵ/R eq.18	3343	2481	2572	1959	2577	1883
Davis eq.19	3221	2548	2491	2026	2547	1986

Table 2. Data for Non-Standard Guns

Case	.17 Rem	16" Gun	Case	.17 Rem	16" Gun
<i>c</i>	22.5	650 lb	measured <i>v</i>	4015	2425
<i>m</i>	25	2700 lb	Webster	4615	2387
<i>l</i>	22.1	689.7 in	Miller ϵ	4055	2500
<i>d</i>	0.172	16 in	<i>a</i>	3758	2675
<i>S</i>	24.991	27000 in ³	<i>l</i> +3.5	3708	----
ϵ	0.9000	0.2407	<i>l_b</i> +1.5	3683	----
<i>R</i>	6.186	6.14	Miller ϵ/R	3935	2448
<i>l_b</i>	24	800 in	Davis	4035	2280
Powder	IMR 3031	Naval			

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Thus all of the considerations in developing loads involve tradeoffs. But this is no surprise. The issue of competing types of efficiency is treated rather nicely in Corner's book [ref. 4(b), also ref. 5(b)] in terms of artillery, but the principles are the same.

In summary, we have examined several velocity estimation rules. Some are good; some are not so good. Although the *a* rules work well for standard guns, in general they are not as good as the two best ones. This is partly because the *a* rules are not based on dimensionless quantities. Therefore we recommend the Miller ϵ (eq. 7) and Miller ϵ/R (eq. 18) rules as useful tools for exploring and comparing proposed loads in the absence of a chronograph. For these practical purposes, you need only these final equations;

you don't have to follow all the technical argument.

One thing we still need to emphasize. **Substantial changes of maximum pressure can occur: (1) if faster powders are used, and (2) if charge or bullet weights are increased. Therefore velocity calculations should NOT be used indiscriminately in developing loads. Comparisons with loading tables are absolutely essential to avoid excess pressures!** In this connection, I offer a slogan:

"A clever reloader, defined as one still alive and intact, is a chicken reloader."

I too can close with the suggestion "have fun," but I hope you now have the tools to actually make velocity estimates.

ALL YOU WANTED TO KNOW ABOUT EYESIGHT (And Were Afraid to Ask)

by
Harold J. Pantely

Dear Dave;

As an avid reader and follower of the PS scribes, I cannot tell you how much I have enjoyed the mag, its information and self-effacing humor that is displayed by all! Kudos, kudos, and even more kudos!

I also made a "great leap of faith" leaving a long-term insurance job to start my own business, in my case a theatre (stage) company! An even more effective way to go broke than publishing, I am told. However, after 17 successful albeit tough years, I have never looked back or regretted my decision. I may never be a household name, but I have had the greatest time and met some of the finest people that walk this planet. I am certain that you feel the same way about the world of shooters, or else you would not be investing the time and effort in what you do. Kudos as well!

Now, to the REAL point of this letter! Being middle-aged, (I'm 50, you know anybody 100?) I read with great interest all the articles about shooters who have "focus" problems, particularly that wonderful group of clods called "highpower" shooters, of which I happily count myself as being so addicted. The problem that I have had is understanding the problem, and what the proposed "remedies" can do to help. Being a Yankee, I am predisposed to "tinkering" and frankly, I just like to know what I am talking about. Well, this summer's disastrous visit to Camp Perry sold me on the idea that I should really try to figure this "shooter focus" problem out, since no one, including those who sold various lenses and gadgets designed to help, could define the problem well, or what exactly their devices could or could not do. Most just said that a "diopter" was an optometric definition for some kind of magnification, and I should buy it, try it, and if it doesn't work, bring it back and we'll try something else. In all fairness, Scott Medesha of Medesha Firearms out there in Arizona seemed to have the most variety of lenses, but then again, there was little in the way of definitions that he was aware of.

Seems that vision is some sort of deep, dark secret, BUT NOT SO TO THIS HERE SWAMP YANKEE! NO SIR! I figure if it is a subject that is taught, then there must be a beginning level of information that can make sense of all this mess, and so, armed with library card, a modem and the Internet, I have been able to come up with the following. Hopefully, this will explain the problem to those who have it or will experience it, what the "visual aids" are that can help, and what to do and where to go for the appropriate help. BY NO MEANS do I pretend to be an expert on the subject. However, defining a problem is the first step in understanding what to do to correct it, so there!

For shooters, the visual problem is the inability to focus upon the front sight, usually a post, and/or the target. First off, it is NOT POSSIBLE for the human eye to focus on a near and a far object at the same time. A "young" eye does have the capacity to shift focus rapidly so that it may appear that both objects are in focus, when they are not. This is called VISUAL ACUITY and diminishes with age as a natural part of the aging process, but more on "aging eyes" later. I have included a few simple drawings to help define what I am talking about here, so a quick reference to them from time-to-time is in order.

The eye is an absolutely amazing device. It is made to accept light that enters through it, control its volume, color, intensity and focus. As light enters the cornea, it is refracted, or bent to a degree, passing through the lens, which can change in shape to further bend the light rays and change their focus as they come together, or converge at a point (a focal point) on the retina. An extremely complex procedure of nerve operations in the retina, called synapses, produces nerve impulses to the brain which result in "vision". For my purposes, the retina, synapses and impulses go far beyond what we are trying to accomplish here! However, the mechanics of the eye in "focusing" is what we are after! Hey, I said I was a Swamp Yankee, not a PhD!

Now for some definitions, HANG IN THERE, DAVE!

REFRACTION/REFRACTED – Light rays that are bent. Light reflecting from an object, which is what enters the cornea, tends to travel in straight or parallel lines until acted upon or bent by any number of different goodies, such as air, the internals of the eye, lenses, etc.

CONVERGENCE – The ability of light rays to COME TOGETHER to a point, DIVERGENCE being the ability of light rays to scatter, or diffuse.

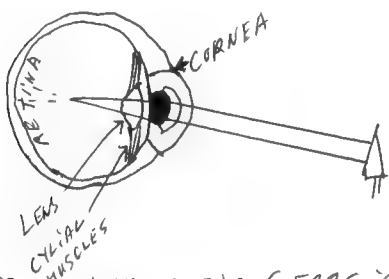
ACCOMMODATION – The ability of the ciliary muscles attached to the lens to change the shape of the lens, thereby changing their convergence to a focal point on the retina.

Now for some more stuff related to our eyes and their problems. Keep in mind that the following are MECHANICAL problems, and are not a result of disease or failing eyesight! The vast majority of us suffer some degree of these problems, and their "cure" requires external devices, called glasses, lenses, diopters, etc. If you were a fat kid in the fifties, such as yours truly, and you wore glasses, you suffered from your friends calling you a "funny-fat-four-eyed-freak." Thank you, modern science, for all those emotional scars! Excess baggage now, I guess. This stuff is not as bad as algebraic equations for trajectories, by the way.

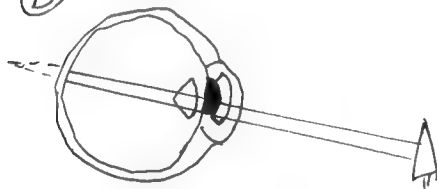
MYOPIA or NEARSIGHTEDNESS (Diagram A) – The nearsighted eye focuses light rays before they reach the retina, their focal point being in front of the retina. From the focal point, the rays diverge, producing a blurred image. A CONCAVE lens spreads the rays before they reach the cornea, correcting the focal point properly upon the retina. Usually caused by a steeply curved cornea, an elongated eyeball, or possibly both.

HYPEROPIA or FARSIGHTEDNESS (Diagram B) – The farsighted eye does not refract light rays sharply enough to bring them into convergence on the retina, the focal point being behind the reti-

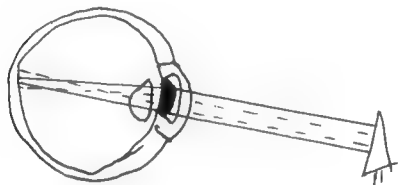
A - MYOPIA (NEAR SIGHTED)



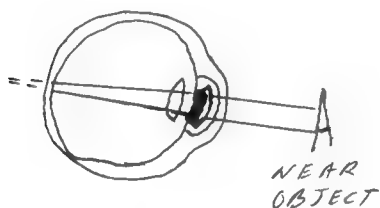
B - HYPEROPIA (FARSIGHTED)



C - ASTIGMATISM



D - PRESBYOPIA (THE CULPRIT!)



NEAR
OBJECT

BIFOCALS



THIS LENS USUALLY CUT INTO
BOTTOM, FOCUSES FOR NEAR
OBJECTS ONLY.

na. A CONVEX lens bends the rays slightly before entering the cornea, correcting the focal point upon the retina properly. Usually caused by a low curve to the cornea, or a shortened eyeball. Children, in particular, can cause their eyes to focus on near or far objects with this condition by forcing their eyes to accommodate, or change the shape of their lens. It gets much harder with age beyond your twenties, though!

ASTIGMATISM - (Diagram C) The irregular shape of the cornea bends rays unevenly, leaving a blurred image on the retina. A CYLINDRICAL lens bends only certain light rays, compensating for the oval shape of the cornea. Obviously, caused by a misshapen cornea!

PRESBYOPIA - (Diagram D) This is the culprit for most aging shooters! As the

eye ages, usually nearing 45 years or so, it loses its power to bring near objects into focus by changing the shape of its lens, a process called ACCOMMODATION. A CONVEX lens, often in the bottom of a lens, bends light inward and helps the eye focus on near objects, like the print on a page, or the front post of a rifle sight!

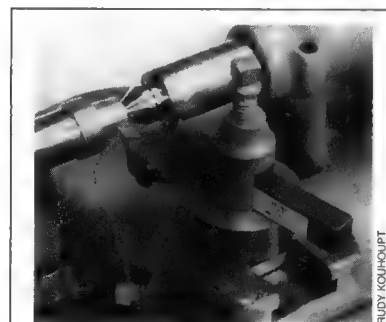
Determining what kinds of lenses will be used to correct a problem OBVIOUSLY calls for an eye specialist with proper equipment. I remember my grandmother buying "reading glasses" at the five & dime by a "trial and fit" method. Not a very sound method, but at the time, maybe the only one available.

PRESBYOPIA, being defined as the problem for "aging" shooters, literally means "old man's eyes." How right they

are! However, the presence of this problem DOES NOT mean impending blindness, as is often thought. Thus, the reference to this condition by saying the eyes are "failing" or "growing dim" is NOT correct! Even the healthiest of eyes will suffer from this. "Old" eyes is more correct, perhaps, but STILL the idea of "losing your vision" is not! With age, actual diseases can occur at the same time, compounding the problem. If you have the SLIGHTEST suspicion that your eyes are "going funny" on you at ANY time, see your eye doctor, period!

I quote; "The cornea and lens together form the equivalent of the camera lens. About two-thirds of the bending of light necessary for focusing takes place at the air-cornea interface, where the light enters the eye. The lens of the eye supplies the remaining third of the focusing power, but its main job is to make the necessary adjustments on objects at various distances. To focus a camera, you change the distance between the lens and film. We focus our eye not by changing the distance between lens and retina, but by changing the shape of the rubbery, jellylike lens - by pulling or relaxing the attached tendons - so that it goes from more spherical for near objects to

Continued on next page



RUDY KOUHOUP

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ALL YOU WANTED TO KNOW ABOUT EYESIGHT

Continued

flatter for far ones. A set of muscles called CILIARY MUSCLES produces these changes in shape." End of quote, thank you, Scientific American and David Hubel!

As we age, again around 45 years or so, the lens HARDENS, making the job of the ciliary muscles much more difficult to accomplish. As the lens hardens, it tends to be flatter in shape, thus the loss of the ability for the ciliary muscles to produce a more spherical shape to the lens, and the eventual loss of being able to focus at near objects. This annoying major irritation of life gave rise to Ben Franklin inventing the bifocal! An eyeglass that can focus in TWO areas, thus the word "bi". I said this was easier than Algebra!

Well, now that we are armed with all this good stuff, what to do? One more definition is in order:

DIOPTR – The power of a lens used to correct refractive errors of the eye is measured in diopters. A lens's focal length, or the length at which the rays passing through converge to a focal point, is determined by measuring the distance between its center and the point at which it focuses parallel rays of light. To obtain the strength of the lens in diopters, the focal length is divided into 100. If the focal length of a lens is 50 centimeters, its power in diopters is 2; 100 divided by 50! A lens with a focal length of only 2 centimeters is therefore a 50 diopter lens. The shorter the focal length, the greater the strength measured

in diopters, and the more "powerful" the lens. For myopia, the strength of a diopter is referred to in a negative (-) number. For hyperopia, the number is a positive (+) one. Hey! Remember that kid in 4th grade, nearsighted as hell, with those "Coke bottle" lenses? Remember how you used to drive him crazy by hiding his glasses, and then laughing like little hyenas as he searched everywhere for them? Usually on his hands and knees and in vain? What a scream, huh? I WAS THAT KID AND I WILL NEVER FORGET YOU! (sob, sob)

Again, a quote for the sake of summary and hopeful clarity. "Presbyopia is an optical flaw that eventually affects almost everyone. As the eyes age, their powers of accommodation decline. It becomes increasingly difficult to bring nearby objects into focus. Because they cannot see nearby objects clearly, some people confuse presbyopia with farsightedness, or hyperopia. But they are very different conditions. An individual with presbyopia can be far or nearsighted and astigmatic at the same time. The lower lenses of bifocals give presbyopic eyes help with nearby objects, no matter what other refractive errors the eyes may have." Thank you, THE EYE and Mr. Lael Wertenbaker!

So, in a nutshell, those of us who are rifle shooters approaching the age of 40 to 45 or so, will experience presbyopia, no matter what other refractive conditions our eyes have. As earlier stated, I have always been terribly nearsighted, squinting away until the second grade when it was noticed by kindly Miss Corr. I have worn corrective glasses ever since, with only minor changes, until age 42, when I began to hold a book out to arms

length to read it. THAT OL' DEVIL PRESBYOPIA GOT ME! Yep, I had to go the bifocals route. However, as far as shooting goes, since the correction is placed in the lower part of the lens, this does not do much for my rifle shooting! And, I do know some vain shooters who still refuse to admit they need glasses, so they shoot with a plain pair of protective lenses, instead of their corrective ones. There is no wonder at all in this here Swamp Yankee's mind why THEY can't see their front sight!

So, what's out there for this problem? I first tried a device called a CLEARSIGHT, moderately priced and available as a clip-on to my regular glasses with three lenses of varying diopters; +.50, .75 and 1.00. The Clearsight was a definite help with a pistol, but the small rear aperture of my rifle tends to negate the effect of the lens. A problem with depth-of-field, too complicated for this explanation. They are a good alternative for pistol and I use the 1.00 diopter. The bull, by the way, is for me, very fuzzy. Can't have everything, I thought.

I then tried a varying rear aperture such as a smallbore rifle has, and found it to help in focusing the sight picture, but I also could lose a lot of brightness. To change the rear sight on my M1A or Garand puts me in the Match rifle category, and given all other considerations, I would then rather shoot a Match rifle to avail myself of the other goodies as well! But, I don't. Swamp Yankees is stubborn.

I then tried a Mid Thompkins front sight modified to take a screw-in diopter lens made by Gehmann. The range of diopters currently available is +.50 or +1.00. Eureka! What a major difference! I

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use the .50 at everything up to 600 yards, with the 1.00 only good for 1000 yards. Since these lenses sit way up in the front sight itself, they have a tendency to actually magnify the sight picture. The 1.00 produces too large a magnification at the shorter distances. I originally thought that this magnification could prove VERY useful, but experimenting showed an IMMENSE error range with high magnification at the shorter ranges. Problems with dust, rain and rifle smoke can haze the hell out of them as well. Also, this is only good for a Match rifle globe type of sight.

Not completely satisfied, I tried a diopter made to fit the rear sight NM style hooded aperture, and found that they are available in a much greater range of diopters and they do not magnify the image, since they are right at the eye itself. By using a diopter in the negative range, I was able to completely clear the sight picture of focus problems. Alas, this is usually a trial-and-error method in obtaining the right diopter power for your particular need. I shoot with my regular prescription bifocals, by the way. Just using a diopter is fine for the sight picture, but I also have to read the number boards and fill out my scorecard, you know! Being able to see the shooter next to me has also proved useful on occasion.

There are other devices available, but I have not tried them, such as the Cyclops and the Knobloch frames fitted with precise lenses. One shooter I do know who uses a Knobloch with a rifle is continually complaining about how they get "in his way." I then met a Distinguished Rifleman who wears a Knobloch, and he would never part with it. Ah, the sanity of it all.

Dr. Alan Toler in Virginia has devised a "kit" that you can rent which is very helpful, indeed. He sends you a set of diopters in both - and + strengths and a frame to fit them in which clips onto your shooting or regular glasses. He then gives you two weeks so that you can go to your range, and under varying conditions and ranges, you can swap diopters liberally (a bad word these days) until you get the sight picture the way you want it. You send the info and kit back, and he grinds that diopter into your lens, or makes a new one for you. I tried this system in August, and was extremely pleased by the results. I found I had to use a combination of - and + diopters to get the right effect. This has the added advantage of allowing me to also use either front or rear diopter for additional corrections given other conditions of light, range or the fact that my eyes will

"change" with further age. As of yet, I am still tinkering with all of this.

As for expense, the immediate and most cost-effective way for a rifle shooter is to try varying diopters in either the front or rear sight. If you are farsighted, try a + power, nearsighted a -. Starting with a .75 and working up or down can be very enlightening. Front sight or rear? The front sight method has an additional magnification advantage, but you will have to change the sight to one that can accept the Gehmann diopter threads. The rear diopter will not require any modifications to the rear sight, and they are available for both the NM hooded rear sight and a Gehmann style variable rear aperture. Anschutz makes a variable diopter front sight, but it WILL NOT stand the shock of a highpower rifle in my opinion. There are others who disagree with this, but be forewarned, they are not cheap in comparison. For less than the price of one, I bought a new front sight with apertures, two front diopters and two rear diopters! ALL my possibilities are covered. Standardizing all my front and rear sights gives me the advantage of swapping around without the additional cost of new sights. Using a service rifle, I use the rear sight diopters and use the Mid Thompsons sight interchangeably. Also, by current NRA rules, you CANNOT use BOTH a front or rear diopter on the SAME rifle, since this constitutes what they term a "telescopic" sighting system. What you do to your eyeglasses is of no consequence.

If you are lucky enough to have an optometrist who is a shooter, then obviously the best route would be to consult with him. There are those that advertise as specialists in the sport. The choice is up to you. For those that cannot, for whatever reason, the front or rear diopter system is a very viable alternative. Perhaps the best of both worlds is Dr. Toler's system. The decision on which way to go should be ruled by pragmatism, but usually is dependent upon the pocketbook. I have included the names and addresses of some of the suppliers for these types of products. Write to them for more info, they are all good people and will be more than willing to help. After all, you are now armed with new info on the problem so go and fix it! The search for accuracy cannot stop!

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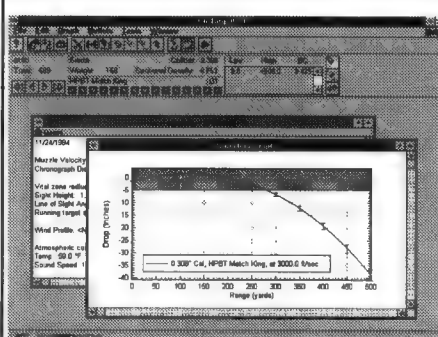
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LET'S GET REAL ABOUT ACCURACY

by
John M. Kolyer

Introduction

The point of this article is that shooters should have enough understanding of target-group statistics to maintain a healthy skepticism about accuracy data and avoid jumping to conclusions. Statistics may be a boring subject, but to ignore it in this case is to live in a dream world. Fortunately, the statistics we need can be expressed relatively painlessly with diagrams and ratios but no mathematical formulas, as we shall see.

We'll discuss the variation in size from group to group for the same rifle/ammo (why the groups vary and how much they vary) and the imperative of comparing averages, not single groups. Practical examples will follow.

Variability of Target Groups

For convenience, we'll discuss only five-shot groups, which are the usual measure of accuracy. These must be fired consecutively to avoid the statistical invalidity of picking and choosing.

All shooters have observed variation in group size (center-to-center distance between the two shots farthest apart). A good example appears in a pistol test in the *American Rifleman*, May 1995, page 53. The ratio of the largest to the smallest five-shot groups in a series of five consecutive groups was 1.57. For additional series the ratios were 2.26, 2.95, 1.85, 1.62, 2.18, 2.23, and 1.54. The average for all eight ratios was 2.03, and ratios of this magnitude can be seen month after month in the *American Rifleman* "Dope Bag" section.

Surely there's no denying that groups vary greatly, but you may ask whether this variation is inherent or merely the result of shooter error or a loose mechanical rest (a Ransom rest was used in the tests cited). In fact, group variability is *inherent* and *inescapable*, as the next section will explain.

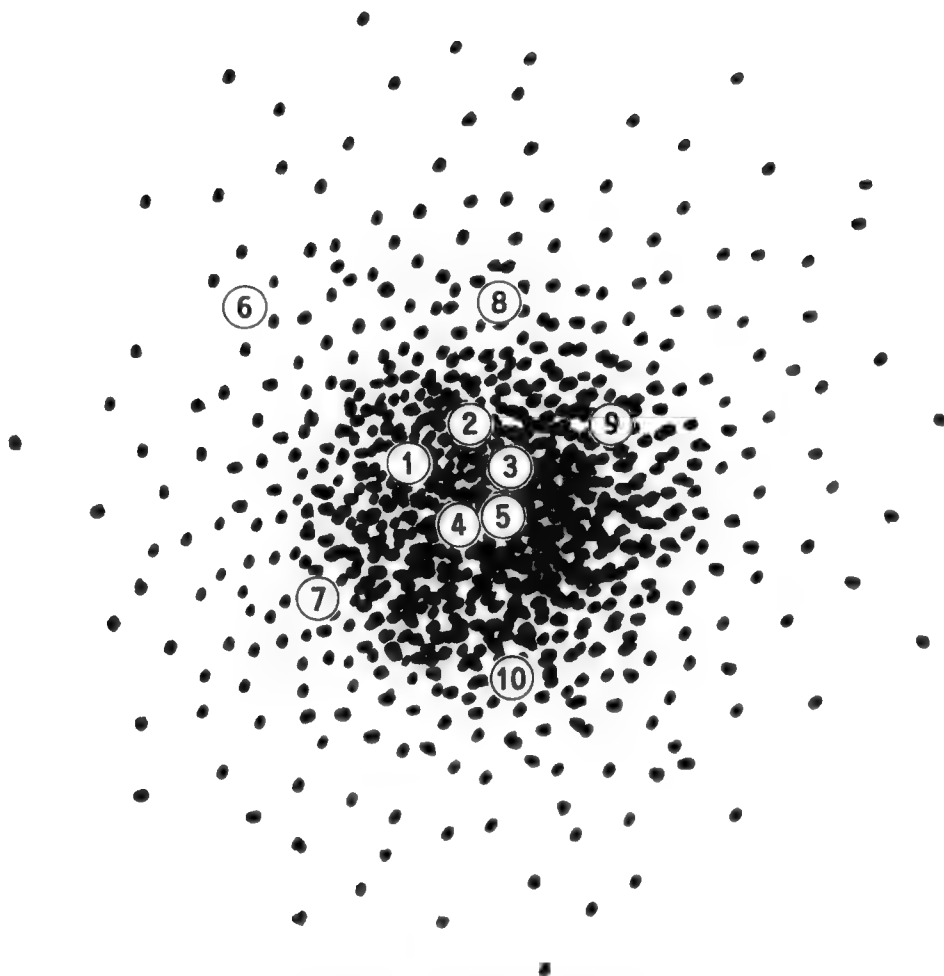


Figure 1. Actual Scatter Pattern



Figure 2. Mythical Scatter Pattern

Why Groups Vary

The accuracy of any missile weapon is described by the scatter pattern of a large number of consecutive shots, say a thousand. What is this pattern? Examine a dart board, an arrow backstop, or a shotgun pattern (a group of many simultaneous shots) and you'll see a nebula-like cluster (Figure 1) with many holes near the center and fewer and fewer toward the edges. Crossbow bolts, sling-shot pellets, baseballs, darts (see *Precision Shooting*, May 1985, page 22), or any other projectiles give the same result.

A five-shot group is just an indirect and very rough estimation of the scatter pattern. A five-shot group is a *random selection* of the multitude of shots in Figure 1. With fairly good luck, the group might consist of shots 1, 2, 3, 4, and 5. This is relatively likely because the pattern is richest in opportunities toward the center. However, with bad luck the group could be 1, 2, 3, 4, and 6, with 6 being a so-called "flier," and with still worse luck the group could be 6, 7, 8, 9, and 10. Or exceptionally good luck could give all five shots near the very center of the cluster; thus, a rifle averaging 0.3-inch groups at 100 yards will give a few percent 0.1-inch "screamers."

Your five-shot groups *cannot avoid* occasional shots from the fuzzy edge of the scatter pattern. Consistent group size is *impossible*, and a rifle consistently shooting groups of, say, 0.5 inch at 100 yards is a myth. What would the scatter pattern be for such a rifle? It would have to be a ring (Figure 2), and even then there would be some variation, e.g., between the group of shots 1, 2, 3, 4, and 5 and the group of shots 1, 2, 3, 4, and 6. Anyone who can shoot a thousand rounds at a single aiming point and get a ring should document the feat!

Since the cluster of Figure 1 is universal, the *only* difference between the best precision rifle/ammo in the world and a slingshot is the *size* of that cluster. Variability will be the same; that is, the ratio of the largest to smallest five-shot groups in a five-group sequence will average something like 2 in both cases. If variability and not group size were the issue, baboons throwing rocks would equal match shooters — not to suggest any other comparison. In other words, groups can be shrunk but never made more consistent. If "screamers" became the norm, "sub-screamers" would occur.

How Much Groups Vary

To illustrate the statistics, which we won't delve into here, a deck was made

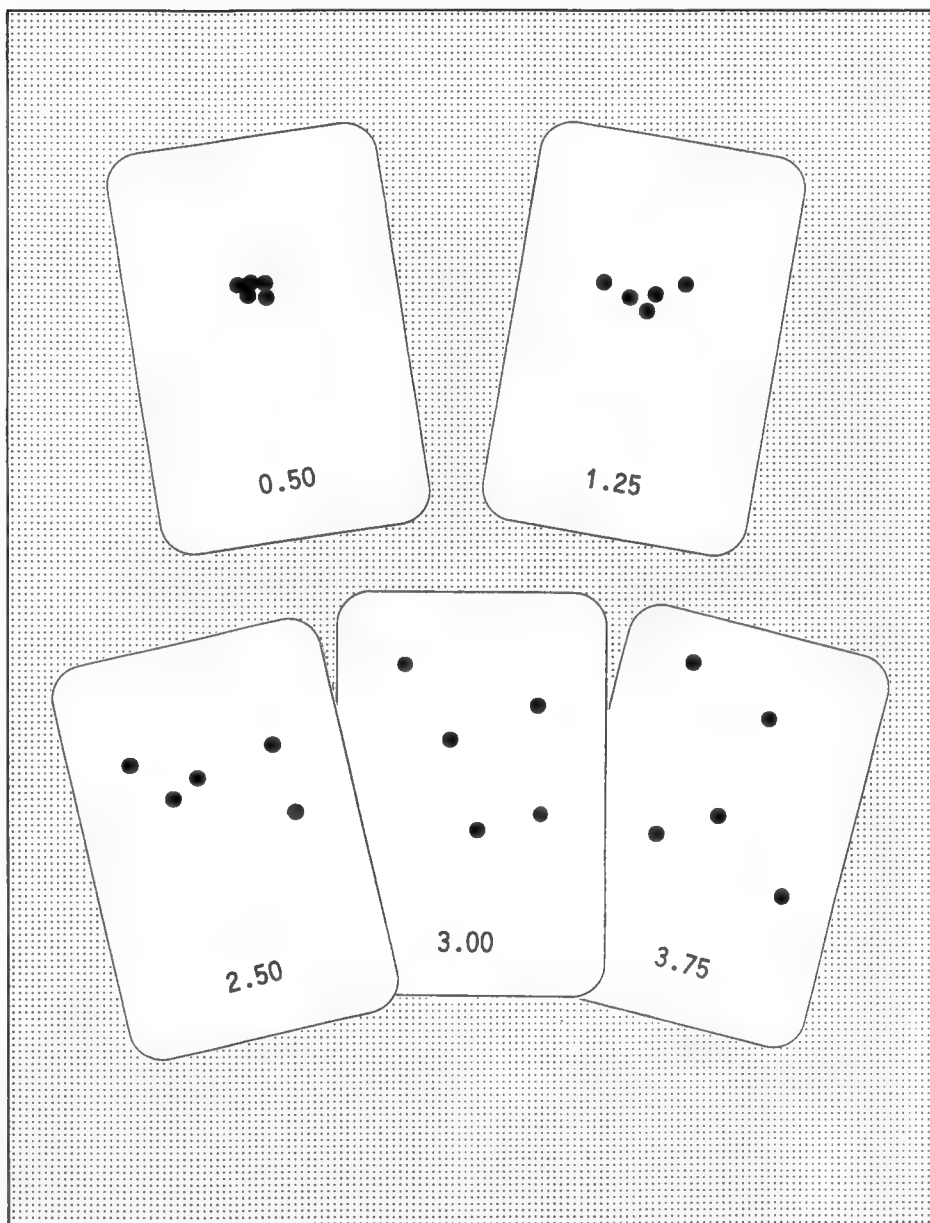


Figure 3. A "hand" of 5-shot groups with extremes that really happen, though seldom.

with 158 cards with five-shot group sizes, in arbitrary quarter-inch increments, in the proportions found in a 1,000-shot, machine-rest test (*Precision Shooting*, May 1984, page 7). (Note to statisticians: The result was approximately the expected rotated normal curve but "tailed out"

slightly more.) Table 1 shows the number of cards in each size category. See Figure 3.

Random numbers were assigned to group sizes, as shown in Table 1, so that there were relatively few numbers for the

Continued on next page

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LET'S GET REAL ABOUT ACCURACY

Continued

rare group sizes, e.g., 0 through 6 = 7 numbers for 0.50 inch, and proportionately more numbers for the common group sizes, e.g., 482 through 627 = 146 numbers for 2.00 inches. Thus, an engineering calculator (Figure 4) can "shoot groups" all day by generating random numbers. For example, we punch up 920 on the calculator, and the corresponding group size from Table 1 is 3.00 inches. Then we punch up 157, corresponding to 1.25 inches, and so on for as many groups as we want. Try this, and you'll find runs of small groups and other interesting effects, all of which happen by chance.

Now that you've understood how much groups vary, you can see that a published complaint about a rifle producing a 0.6-inch group followed by a 1-inch group is naive. This is just the sort of variability to be expected, and its absence would mean the absurd ring pattern of Figure 2.

Working With averages

Single groups vary so much that they are poor indicators of accuracy. Averages of five successive five-shot groups, as tabulated in NRA tests reported in the *American Rifleman* magazine, are much better, but these averages also vary, though less. This variation of averages was demonstrated with the cards by dealing successive hands of five groups. The first hand (five cards) averaged 2.30 inches. Then these cards were returned to the deck, which was shuffled well before the second hand was dealt. Repetition of the process gave 1.95, 1.70, 1.80, and 2.05 inches. The grand average of these five averages was 1.96 inches, which is the average of all the cards in the deck. Note the variation: 1.70 to 2.30 inches.

Though one five-group average is only a ball-park number, as we have just shown, it's a reasonable compromise between confidence and labor. Incidentally, when you shoot five consecutive five-shot groups, remember that rejecting even one "bad shot" or "flier" will invalidate the test. Also, the average is best expressed as minutes of angle (MOA) for range-independent comparisons. One MOA = 1.0472 inches at 100 yards or 0.105 inch at 10 yards. Thus, a cartridge rifle averaging 3.1 inches at 100 yards and an air rifle averaging 0.31 inch

Table 1. Size Distribution for Five-Shot Groups

Group Size; inches	Number of Groups	Random Numbers
0.50	1	0-6
0.75	4	7-32
1.00	10	33-95
1.25	17	96-203
1.50	20	204-329
1.75	24	330-481
2.00	23	482-627
2.25	19	628-747
2.50	14	748-835
2.75	10	836-899
3.00	7	900-943
3.25	5	944-975
3.50	3	976-994
3.75	1	995-999
Total = 158		

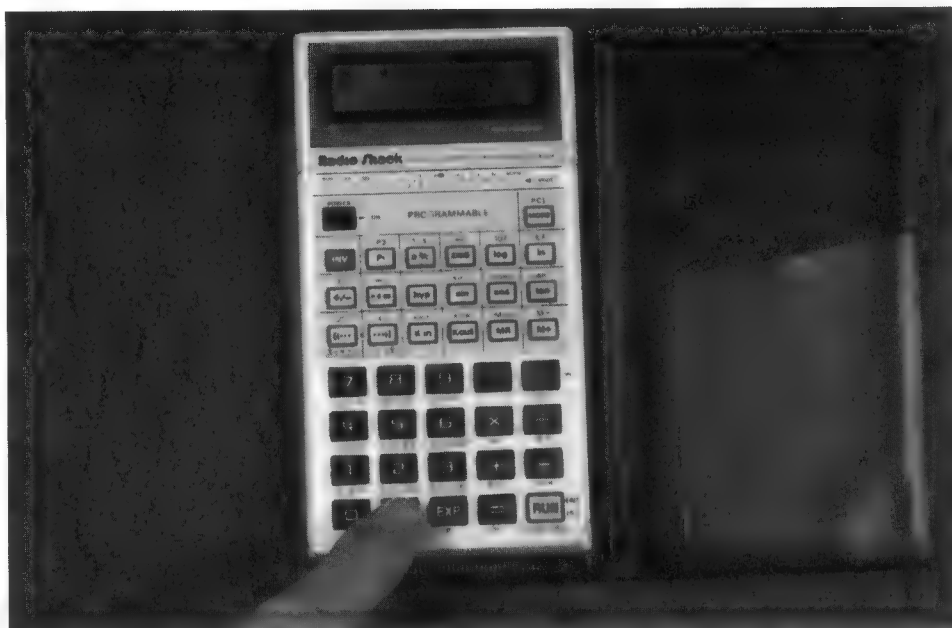


Figure 4. This calculator "shoots groups" by generating random numbers (neglect the decimal) for use with Table 1.

at 10 yards are equally accurate (3 MOA) at their respective ranges.

You can use five-group averages to categorize ammo for accuracy, but remember that these are only ball-park numbers. For example, five-group averages of 3.04 and 3.12 MOA are statistically indistinguishable.

Then how much must five-group averages diverge to be "really different"? There is no easy answer; as the averages get further apart we become more confident but never certain. Table 2 gives confidence levels. For example, if ammo A gives a five-group average of 2.00 MOA and ammo B gives 2.80 MOA, the B/A

ratio is 1.4, and Table 2 shows that the probability that A is really smaller than B is 95%. "Really smaller" means that if hundreds of groups were averaged, A would continue to be smaller.

In using Table 2, be cautious even with high confidence levels. A probability of 98% is high, but it isn't certainty, and accidents happen and lotteries are won with much less than 2% probability. Always remember the improbable *does* happen.

Practical Examples

We should "get real about accuracy" because the illusion of consistent or

Table 2. Probabilities and Confidence Levels

Percent Probability that A is Really Smaller than B	Confidence	Ration B/A for Averages of Five Con- secutive 5-Shot Groups
50	None	1.0
51-79	Low	—
80	Fair	1.2
90	Good	1.3
95	Very Good	1.4
98	Excellent	1.5
(but not certain)		

reproducible group size can cause rash decisions as seen in the following five examples.

1. The first example comes straight from the *American Rifleman* pistol tests cited above. The five-group series for ammo A averaged 3.05 inches with the largest group 3.72 inches, while the series for ammo B averaged 4.10 inches with the smallest group 2.51 inches. Then, if only one group, the 3.72-inch one, were fired for ammo A and only one group, the 2.51-inch one, were fired for ammo B, the statistically ignorant conclusion would be that ammo B is better. However, the wise averaging of more groups would shift the preference to A.

2. Using an out-of-the-box sporting rifle of mediocre accuracy and factory ammo, three shooters have a contest. The young man shoots a 2.25-inch group, the older man shoots a 1.50-inch group, and the latter's wife shoots a 3.75-inch group. Many or most shooters will say, "Experience won as might be expected, and of course the woman lost." However, the statistically aware skeptic (realist) will say, "Nothing at all was proved, because groups by the same shooter vary so much in size. Many more groups must be fired to decide the contest." And in fact at the end of ten groups fired by each shooter, with ties counted as a win for both parties, the men each won four rounds and the woman won five. She also — by chance — had the smallest group of the contest, 1.00 inch. The grand averages were not significantly different, and all the groups could have come from the same shooter and were dealt out of the deck of cards described above. Were you among the dreamers who thought the initial results were meaningful?

3. You have been using moderately priced bullets for handloading, and you buy a sample quantity of expensive, "super" bullets for comparison.

Expecting the new bullets to be more accurate, you fire a 1.2-inch group at 200 yards with the old bullets vs. a 0.75-inch group with the new ones. You feel your expectation was confirmed, and you invest in a large supply of the new bullets. However, prolonged shooting shows the new bullets to be no more accurate on the average than the old ones. What went wrong?

The ratio of group sizes was $1.2/0.75 = 1.6$. If this ratio had been for five-group averages, you'd have had over a 98% chance of being right that the expensive bullets were more accurate (Table 2). However, for single groups, as was the case, you had only an 80% chance, or 4 out of 5, of being right. Unfortunately, you also had a 20% chance, or 1 in 5, of being wrong, and you were wrong — like someone who shoots himself playing Russian roulette with a five-chamber revolver with one chamber loaded. You've been wasting money on the expensive bullets because you jumped to a conclusion. You should have compared five-group averages.

4. A friend offers to sell you his expensive rifle, and you buy it based on your firing a 0.42-inch five-shot group at 100 yards. However, you seldom equal this performance again. Your groups average

about 0.8 inch, which is good but not the outstanding accuracy you got on the first try. You're disappointed. Has the rifle "gone sour"?

A change in any gun is always possible, but probably your first group chanced to be toward the low end of the statistical spectrum of group sizes. You naively assumed that this single "lucky" group represented the average. Hence the rifle you bought was overrated — by your own rash judgment. You should have averaged five groups.

5. The first day at the range with a new rifle you shoot five-shot groups of 0.9 MOA, 1.0 MOA, and 0.7 MOA, and you go home happy with your "sub-MOA" rifle. However, the second day you get 1.4 MOA, 1.5 MOA, and 1.3 MOA, with fliers in the last two groups. You're depressed by this "bad day" and wonder if your technique was to blame. Was it?

Your technique *might* have been off, but the inherent variability of groups could explain the result. "Fliers" can happen quite naturally by being simply shots at the high end of that pesky spectrum of group sizes. Don't blame yourself without firmer averages.

Conclusion

In conclusion, be skeptical regarding accuracy data. In particular, beware of claims based on single groups. For example, a rifle-manufacturer could shoot hundreds of targets to get the 0.5-inch "bragging group" in Table 1 to show in his advertisements, whereas the average was almost 2 inches. Statistical scatter is a fact, and the resulting doubt is annoying, but technologists, including accuracy-seeking handloaders and rifle-assemblers, must live with it. Work with averages and know the probabilities of your conclusions being right.

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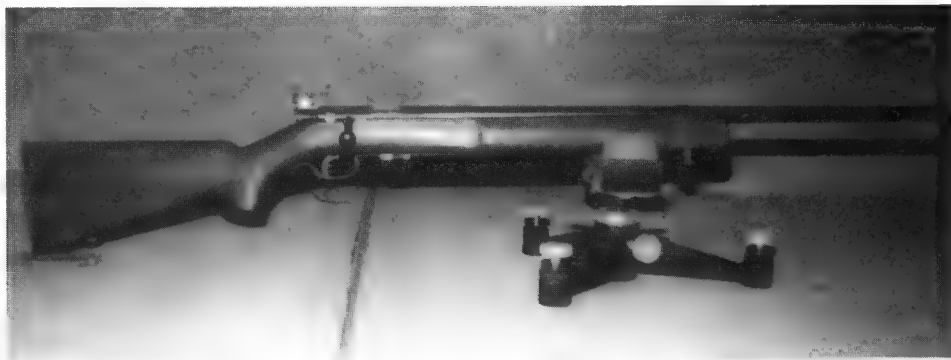
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THE MODEL 75 ONCE AGAIN

by
William Law Hartman

What is the fascination with these beat-up Model 75s? For what was obviously intended to be a fairly basic rifle, there is something about them that just makes for good shooters. Their situation is analogous to the Remington 788 or the Ithaca Model 37 shotgun. Too many of them just work too good. They represent some (probably inadvertent) combination of fit, straightness of the bore, and the ability to deliver shots consistently. I own one of these Model 75s.

I had finished reading an article about converting old .22 target rifles into sporters, and decided this would be a neat project to work on in my spare time. The type of project where you can redo the stock and metal in spare moments, and if it takes a year or so to get finished, well that's OK too. There is a lot of satisfaction in breathing new life into old equipment of all types, not just guns, and I found this idea appealing.

I had on hand a used equipment list from Neal Johnson, and as luck would have it there were two Winchester 75s for sale. I didn't even know what a Model 75 was, but I did have a 1950's era book on shooting that described it as a "medium-priced target rifle" and included a drawing of one. (Fig.1.) The guns in Johnson's list were described as being in fair condition with one being slightly better than the other. The price was \$150 each. I phoned Johnson's and was told that the better of the two had been sold. The one left had a "modified" stock, was old, and showed a lot of wear, but was otherwise serviceable and complete. They told me I could send it back if I



Fig. 1 Winchester model 75 target rifle.

didn't like it. I gave them my credit card number and told them to hold it until I could send an FFL.

A week later the gun arrived with the barrel and receiver out of the stock to provide a shorter and less damage prone package. It was old all right, and did indeed have a lot of wear. It looked as though it had spent most of its days in a Boy Scout or camp organization somewhere as part of a marksmanship training

program. I doubt it had ever been cleaned, and it was a perfect combination of dirt, oil, and old varnish. The stock "modification" was something I have never seen before and like most PS readers I have looked over a lot of guns in my years of shooting and hunting. What someone had done was to saw the comb of the stock completely off. (Fig. 2.) The indent that normally appears where the thumb wraps around the grip

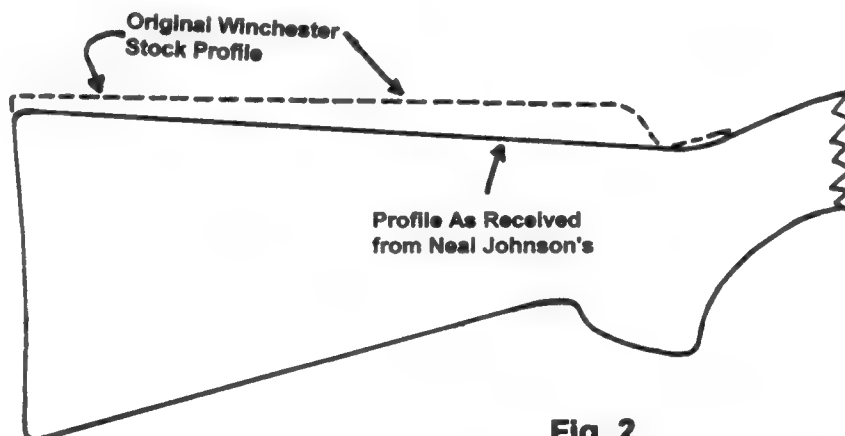


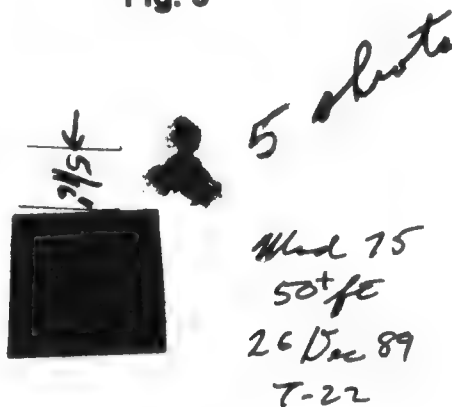
Fig. 2

was gone. The sharp edges were rounded off with a file, but the top of the buttplate was flat and square. In spite of this modification, the stock fit well, and the Lyman sights fell into my line of sight perfectly. When I eventually saw an unmodified Model 75 on a dealer's rack it became clear why the stock was modified as it was. The original sights (Lyman #58E rear and Winchester #105 front) were mounted much higher than the sights on my rifle. This Model 75 had a Lyman #57E, which evidently came standard with the less expensive Winchester Model 6941 Match Rifle, and sat much lower. Part of the stock near the receiver had been cut away to make room for the aperture slide. What happened to the original sights is any one's guess, but the replacement rear sight bolted right on and fit perfectly. The front sight was a Lyman 17A and Johnson's had thoughtfully included a small plastic box with a variety of post and aperture inserts. The trigger pull had an unusual feel, but seemed to work well with minimal creep. It didn't let go when the butt was tapped on the floor, or the receiver rapped with a nylon hammer. After looking it over I decided there was still enough wood — since there was a lot to begin with — and I could probably remodel the stock to a set of trim dimensions that would go well with a shortened barrel. The basis for my project still seemed intact. The next step was to shoot the thing and see if it was reasonably accurate before I put forth any further effort. What I thought I was looking for was maybe inch or so groups at up to fifty yards. Something suitable for a little informal target shooting, plinking, or an occasional squirrel. Never having been a big-time, small-bore shooter, I have, however, always had good luck with Winchester T-22 ammunition. I grabbed a box, my Wichita rest, and the rifle, and headed to the range. I set up a target part way to the 100 yard back stop. It was just a piece of heavy, white paper stapled on a stake. A square of electrical tape made for an aiming point. Distance was something a little more than 50 feet. Beyond that and the front sight subtended the piece of tape. I wasn't too particular since this was only going to be a quick screening test.

The December day was cold but the air was still and damp from recent rains. I selected a post sight from the packet of front inserts, screwed it in place, laid the rifle on the rest, put the square dot of black tape right on top of the post, and got off five fairly quick shots. I expected to be able to see a scattering of shots somewhere on the paper since it wasn't

that far away. I hadn't bothered to bring my spotting scope and box of shooting gear. Sometimes it's nice to try to keep things a little simpler. But there wasn't any scattering of shots, in fact I couldn't see much of anything except the tape and what I thought might be a hole at one o'clock. Since I hadn't done any bore sighting I thought I could well be off the paper entirely. (At this point I'm sure you can guess what's going to happen.) I waited till the range was safe and walked down to look at the target. There were all five shots, touching each other, next to the tape, in what is one of the nicest groups I have ever shot with anything. (Fig. 3.) My perspective on this old .22 underwent a sudden transformation. I replaced the target, and went

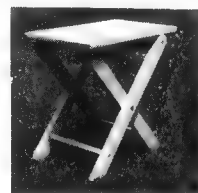
Fig. 3



back to try again. Same results. I never considered myself to be an outstanding rifle shot, but I seemed unable to do anything wrong with this rifle. It shot great — and with fairly pedestrian ammunition to boot. Additional time at the range and a little squirrel hunting after bow hunting, only confirmed that this was a good rifle. It also worked just as well with RWS Subsonic ammunition, which made a safe load for getting rid of nuisance starlings. I next entered the rifle in a 100 yard, benchrest match at our local club. I had only shot one benchrest match before in my life, and that was for center-fire sporting rifles. In spite of windy conditions, the rifle was good enough for 2d place (just missed 1st) in the Iron Sight classification using the same T-22 ammunition. Most of the people who shoot in these matches tend to have pretty fancy equipment, and the old Model 75 was last on that list by a wide margin.

At this point, I needed to rethink my original plan to restyle this rifle into a sporter. It didn't take much thought to

reach the conclusion I should leave it pretty much alone. I did decide a thorough cleaning wouldn't hurt anything, and since the barrel had already been out of the stock, taking it apart again shouldn't matter. I disassembled the metal down to the last screw, and carefully cleaned and lubricated each part. I decided to refinish the stock at the same time, since half the original varnish was gone and what remained was in terrible shape. Looking at the stock more carefully, it seemed as if it could be remodeled once more. There was plenty of wood to provide both a new pistol grip and a more comfortable comb, without affecting the dimensions that worked so well with the current sights. The steel buttplate also got a new contour. I use a special rasp obtained from Brownells some years ago (Patternmaker's Cabinet Rasp, smooth cut, Nicholson #50) for all major stock work. While expensive, they work particularly well. If you plan on doing any significant amount of stock work in your shooting career, I highly recommend you buy one. As the accompanying photo shows the stock came out very well. (Fig. 4.) The color and grain of the wood were quite plain, and I used a dull, basic finish, that goes nicely with the overall well-worn patina of the metal. I did add a 1&1/4 inch black nylon military sling for carrying only, which makes it comfortable to take into the woods. The old target rifle might not look as sleek and up-to-date as the current crop of high-grade rimfire sporters — but I'm certain it will shoot with the best of them. I don't think I'll be selling this rifle anytime soon — and the thought of exercising my return privilege with Neal Johnson never even crossed my mind.



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HOW TO MEASURE GROUPS

by
Dan Hackett

It would seem that if there ought to be something all shooters can agree on, it is the sizes of the groups we fire and the way they are measured. Yet this is patently not the case.

Examination of groups fired by different people, including some reproduced in magazines and custom-shop sales literature, reveals that measurement figures don't always mean the same thing. One guy's "half-inch" group may look just like one that another fellow measures to be a full fifty percent bigger. Nor are such anomalies limited to technically unsophisticated or inexperienced shooters. Not long ago, this very publication published some photos of groups which were at least twice as big as the measurements written beside them, yet somehow still slipped past our esteemed editor's very practiced eye. The fact that such things can appear even in the pages of *Precision Shooting* is eloquent testimony to the frequency with which inaccurate measurement occurs. (Editor: We are pleased to announce that we have an opening for a new columnist. Residents of Wisconsin need not waste their time by applying.)

What significance all this may have depends on how you look at it. On the one hand, it's hardly a matter of cosmic importance if someone's group measurements are consistently off by a tenth of an inch. But there is another issue here, that of communication.

These measurement discrepancies are common enough that if Joe Shooter says he fired groups of such-and-such size, no one can be sure of what he really means without seeing his targets. This in turn creates uncertainty about any accuracy-related information Joe might want to pass on. In a nutshell, we don't know how much weight to give his advice and opinions unless we are sure his results are correctly reported.

Obtaining and exchanging information within the Precision Shooting community is and always has been vital to the progress of our sport. This transfer of information is hampered to some extent if we don't all follow the same standards for measuring our results. With due regard for readers who might think the topic is old hat, I believe this issue of

communication is important enough to warrant covering the basics of group measurement here in *Precision Shooting* so all readers will at least be aware of how groups are supposed to be measured.

Measuring What Isn't There

Accepted convention is to score a group according to the distance between the centers of the two most-widely separated shots. This has the advantage of applying equally to all bullet diameters, unlike measuring from outside to outside or inside to inside of the holes, but introduces a dilemma: the center of a bullet hole is a point in space whose location must be inferred rather than precisely located.

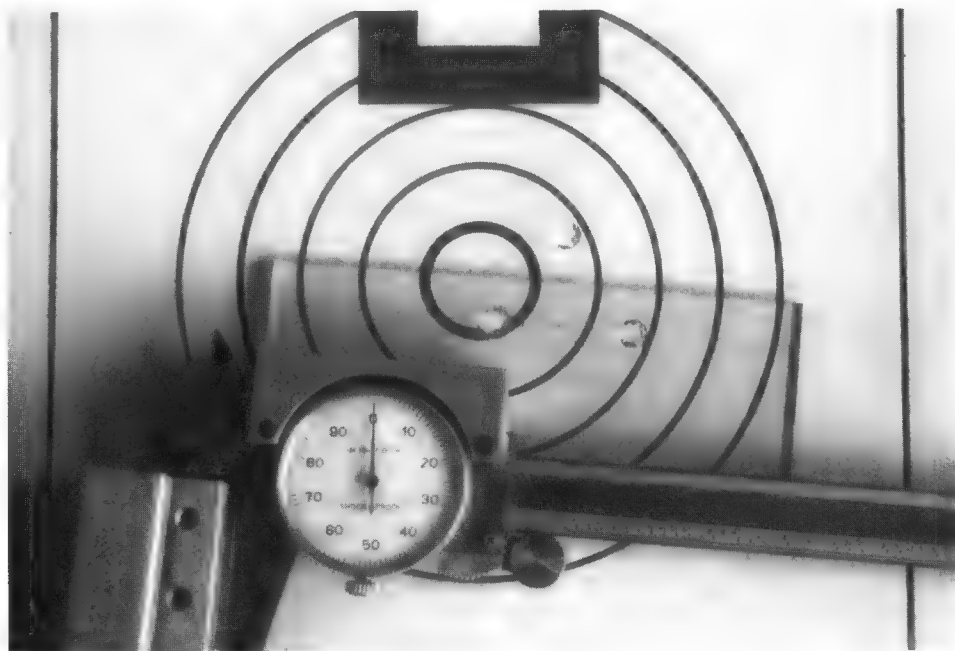
The most common way to get around this lack of a fixed center point is by the apparently logical method of using a caliper to measure from outside edge to outside edge of the most widely spaced holes, then subtracting a bullet diameter. This technique is employed by many individual shooters, by some organizations that sponsor benchrest matches, and by the technical staff of at least one prestigious firearms publication. But while it appears to make perfect sense, it doesn't produce accurate results—even though

they are usually expressed in thousandths of an inch.

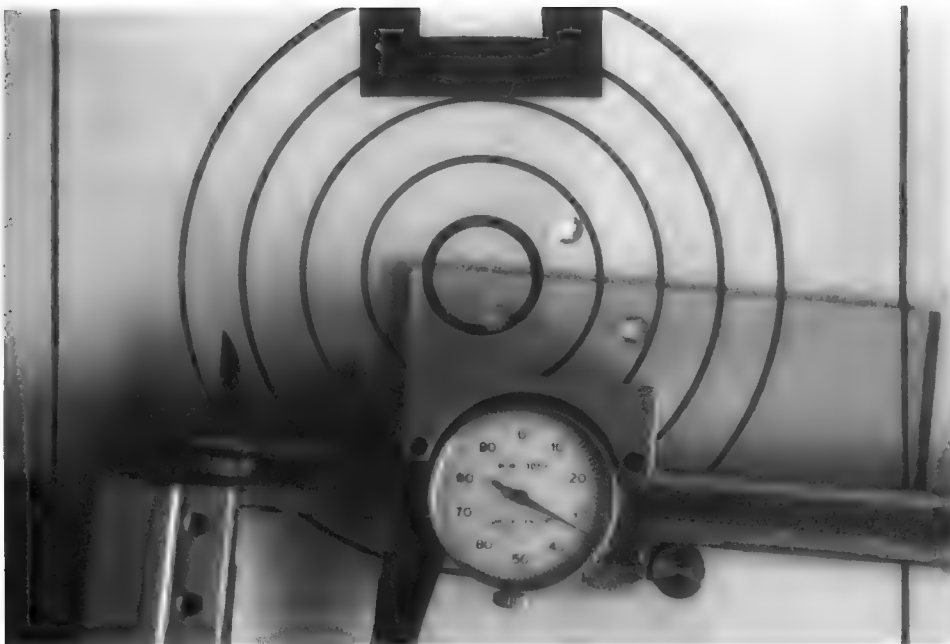
There are two fundamental reasons for this. First, it is impossible to precisely locate the exact outside edge of a bullet's mark on a target. Second, and contributing to the first, paper stretches while a bullet passes through it, so the print left on the paper is not actual bullet diameter. These two interlinked effects combine to produce a calculated group size which is almost always smaller than the group's actual spread.

The founders of organized benchrest competition long ago recognized the problems inherent in locating the center of a bullet hole, and came up with an ingenious and elegantly simple solution: centering the entire hole in a circular reticle.

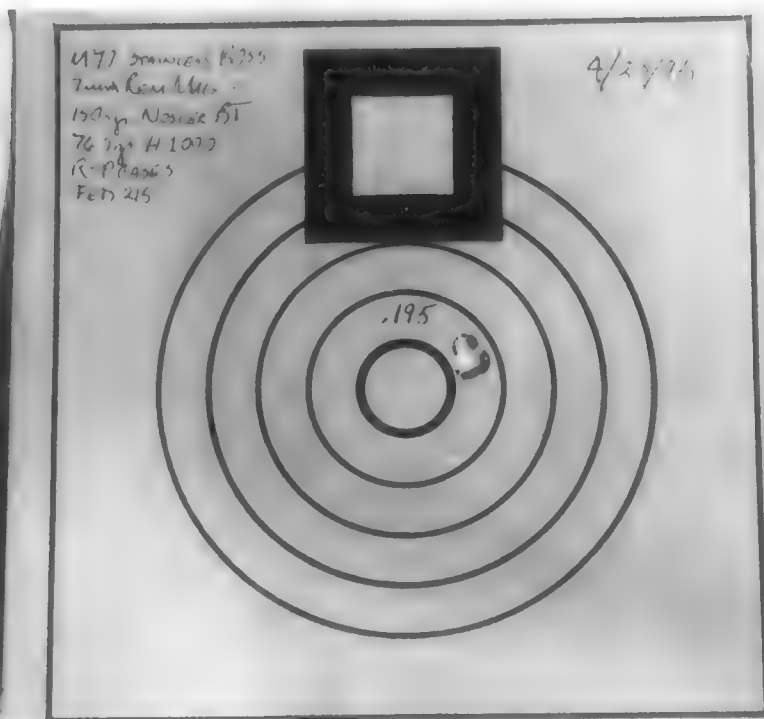
In spite of its weaknesses in other areas, the human eye is quite adept at telling when two circular shapes are concentric. Scribe a thin bullet-diameter or slightly larger circle on a piece of transparent material, then put that material over a target, and you'll be able to center a bullet hole in the circle within a few thousandths of an inch, even without magnification to aid you. *This means you have also located the hole's center to the*



First, center leftmost bullet hole in circle of appropriate size, with caliper jaws closed....



Then, anchor caliper and open jaws until the same circle is centered on the rightmost hole. Voila! Caliper reading (1.133 inch in this case) is group size. It isn't always as easy to center the outside holes as it is with this very non-match-grade factory ammo, but the principle is always the same.



Author's best attempt to measure this group with plain caliper and arithmetic gave 0.180" result—0.015" undersize. Five other shooters using the same method got dimensions ranging from 0.147" to 0.168", but were off no more than 0.005" when allowed to use the Jones fixture.

same degree of precision. Now all you need to measure a group very accurately is some way to keep track of the distance the circle travels as you move it from one hole to another.

The device resulting from this idea ends up being something like the Neil Jones Custom Products target-measuring fixture shown in the accompanying photographs.

The fixture consists of two main parts or assemblies. The first part is a block that attaches to the fixed jaw of a dial or digital caliper, and contains a spring-loaded plunger with a sharp point. The second part attaches to the caliper's movable jaw assembly, and holds a clear plastic plate that is scribed with several circles of different standard bullet diameter along a straight scribed line.

Making the Measurement

Basic use of the fixture is simple:

1. Place your target on a flat, non-metallic surface, and orient it so the two most-widely spaced shots are horizontal from your viewpoint.
2. With the caliper jaws fully closed, center the appropriate circle around the leftmost bullet hole and align the reticle plate so the scribed line passes through the approximate center of the rightmost hole.
3. Without disturbing the caliper's position on the target, push down and hold the plunger so its sharp point locks caliper and target together on the flat surface, then open and adjust the caliper until the same circle is centered around the rightmost hole.
4. Read group size directly from the caliper.

Simple as this is compared to other methods, you should remain aware of two potential problem areas:

It is normal to obtain slightly different readings every time you measure a group, due to changes in light and the way your eyes perceive the reticle and bullet holes. Rather than making just one measurement, make two or three, starting from scratch each time, then go with the average.

If you're measuring really good groups, you won't have entire bullet holes on which to center the reticle, because their overlapping inside edges have been shot away. All you can do is make the reticle circle as concentric as possible with the outside edges of the holes you're working with. You should always have more than 180 degrees of hole circumference to go by, however, and this should be enough for precise results. Just remember to maintain the same contact or

Continued on next page

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HOW TO MEASURE GROUPS

Continued

spacing between circle and hole all the way around—*don't* just “bump” the reticle circle against the part of the hole that's farthest from group center.

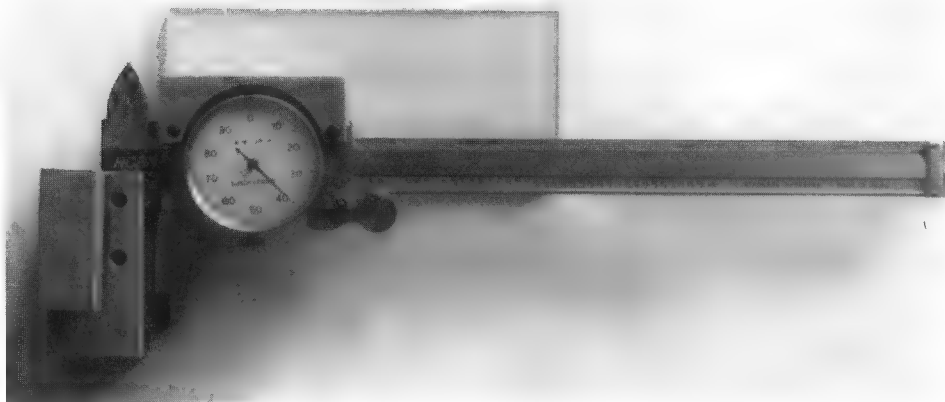
I find I get more consistent results if I use a reticle circle that's one caliber larger than the bullets I'm shooting rather than one of matching size. It's a little easier for me to center the circle by maintaining an even gap around the hole than to cover the edges of the hole with the circle and then try to guess where they are. You may prefer having the circle contact the bullet marks. Whichever way you do it, just remember you want the circle centered on the hole rather than contacting it on one side.

Magnification helps. Any kind of magnifier that leaves your hands free to operate the caliper will work. Neil Jones offers an optional magnifying lens that attaches to the target measuring fixture shown here, and is quite handy.

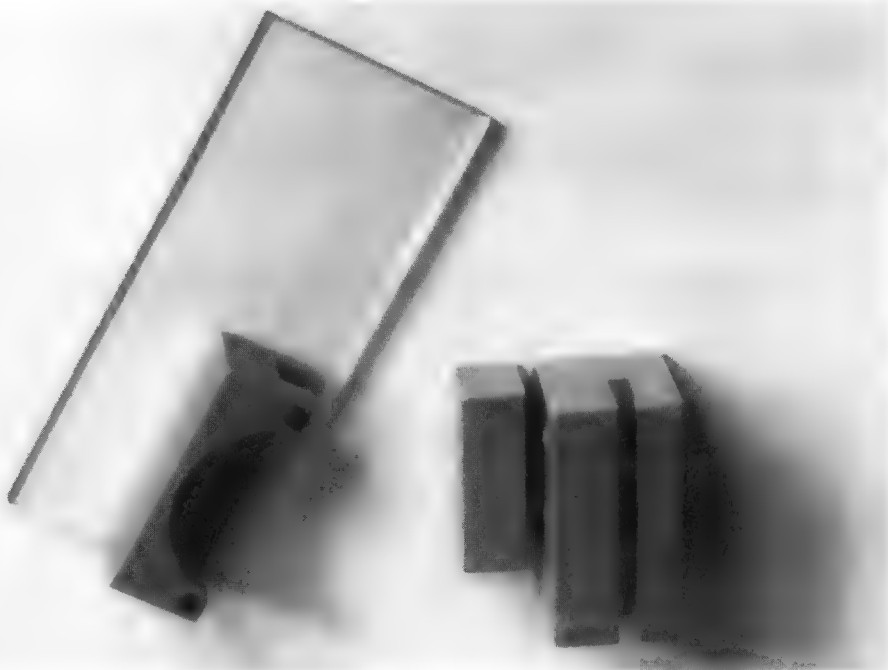
The most important thing you can do to improve the precision of your measurements is practice making them. You should reach a point where repeated measurements of the same group produce results that vary no more than two or three thousandths of an inch, which is about as good as anyone can manage.

The Last Problem

Having covered the basics of accurate group measurement, we are left with one serious problem: expense. Using a relatively cheap dial caliper and omitting the optional magnifier, you will ruin a C-note setting up to measure your groups with the Jones fixture. Going first-class with a



Neil Jones/Custom Products target-measuring fixture. Smaller block on left part is handle of anchoring plunger.



Ordinary RCBS dial caliper is shown with Jones fixture attached.

topnotch caliper and a magnifier will up the ante to well over \$200. These are pretty serious hits if your shooting budget is limited.

This strikes me as an area where some enterprising guy or gal could amass some jingle while doing all shooters a big favor. It isn't difficult to imagine an inexpensive (\$19.95?) dedicated group-measuring device based on a vernier caliper and made from molded fiber-reinforced plastic. Such a gadget wouldn't be quite as precise as the current high-priced alternatives, but it would be accurate enough for anything but all-out IBS competition, cheap enough for any halfway-serious shooter to afford, and it would get everyone speaking the same language with regard to group size.

As I see it, the only reason not to offer a device like this is that potential manufacturers don't see a demand or a need for it. But the precision shooting and reloading marketplace has never sat around waiting for consumers to say what they want. The more common scenario is for some ingenious soul to come up with a new gizmo that fills some unacknowledged need, then let it create its own demand. An inexpensive group caliper would seem to fit this pattern very well.

How about it, boys and girls? Anybody out there willing to take a chance on selling something almost every shooter needs, even if unaware of the need?





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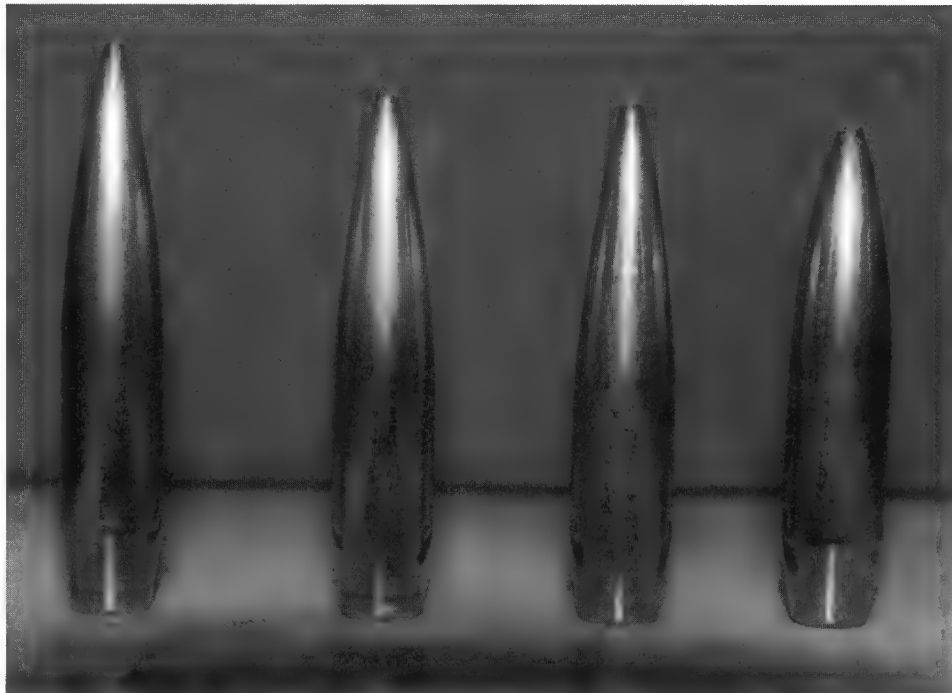
BALLISTIC MISSILE DESIGN:

Design and Testing of the New Wall Low Drag bullet.

by
Theron King

Along about 1989 or 1990 the low drag bullet craze invaded highpower rifle shooting and 30 caliber low drag bullets became all the rage. Many manufacturers jumped on the bandwagon, and seeing as how the 30 caliber boys were trying to catch the 7mm boys in the BC department, it was only natural that someone would eventually create a low drag 7mm to maintain the BC gap between the 30 caliber and the 7mm. Sure enough, Jimmy Knox introduced his 7mm low drag bullets and I had to try some. They worked great! I shot them for about a year then began to wonder if anyone would ever make a lighter 7mm low drag bullet. It seemed logical to me that a lighter 7mm low drag bullet, say 155 grains, would have a good ballistic coefficient and less recoil than the current 7mm bullets. It also should be capable of being driven faster in any given case due to the lighter bullet weight, less case capacity loss than longer bullets and the shorter bearing surface. (Sort of like "shoots great, but less filling", in the case that is!) However the trend in low drag bullets seemed to be to make them heavier and longer. I tried to convince Sierra Bullets to make a lighter 7mm low drag bullet. I figured with the right design it would have the same ballistic coefficient as the 168 Sierra or maybe even close to the 168 JLK with the added advantage of higher velocities due to a shorter bearing surface and lighter weight. My personal campaign for lighter low drag bullets didn't go very far even though I have some close contacts deep within Sierra's ballistics department. (Rumor has it that they said I was a wimp, and **should** shoot big bullets, but couldn't take the recoil!)

Well next thing you know, Sierra and everyone else jumps on the 6mm shootin' star band wagon, especially after the Nationals gets won by a 6mm in 1992. Only problem is that unless you are made of gold, you can't afford to shoot the 6mm due to barrel life being just a tad short! (1800 rounds is just about enough for me to get comfortable with a rifle and my zeros, not time to take the barrel off!) Now I am beginning to think that the 7mm is the only way to go! In



Left to right: 185 Wall LD, 168 Wall LD, 168 JLK LD, 168 Sierra Matchking.

spite of the latest craze being the 6.5mm, I still feel that the 7mm is a better round for highpower shooting. So I got serious and started figuring out how to design my own 7mm bullet because I couldn't convince anyone else to do it. Soon I have several drawings made up but can't decide if I should sink a lot of money (I do mean **a lot!**) into having a set of dies made. So I put the drawings on the shelf and continue to shoot JLK 7mm low drags.

Several months later (February 1994 to be exact) serendipity paid a visit to a good friend of mine named Ron Wall. He was let go by one of the major defense contractors in our area. However Ron was fed up with corporate America and decided to try working for himself. He called me one night and asked if I thought anyone would buy those 7mm low drag bullets if he was to make them! I said there's only one way to find out, so the next day we made arrangements to send the drawings to Bob Simonson in Michigan and have a set of dies made.

This was not really a partnership, in fact Ron put up all the money himself. He only relied on me to provide the design of the bullet, which I did. My payoff would be getting to shoot a lighter low drag 7mm and maybe shoot some better scores with them. After several months of waiting and several delays (Bob said the kidney stones were **really big!!!**) the dies arrived and Ron started making bullets.

Soon as I could I made the time to take a trip to Ron's place and test the bullets. Ron lives about 130 miles east of me near the thriving metropolis of Inola, Oklahoma and just happens to have a 300 yard range about 50 feet out his back door! We loaded up a number of different loads using three different bullet weights (140, 155, 168 grains) and promptly went out back to test them. I brought my chronograph (original Pact PC) plus a borrowed one from a friend, Don Blimm, (who came along ostensibly to help, but probably to insure that I didn't center punch his brand new Pact

Continued on next page

BALLISTIC MISSILE DESIGN

Continued

Professional chronograph!), Ron had his own chronograph. (Ohler 33) We originally set them up with Ron's at 300 yards, Don's at 100 yards and mine at the muzzle. We ended up with Don's at the muzzle and mine at 300 yards due to batteries in Ron's chronograph giving up the ghost. Our intent was to test Sierra's 168 7mm and JLK's 168 7mm and compare them to Ron's newly made bullets. The hope was that Ron's bullets would have a higher ballistic coefficient for the same bullet weight and that the lighter bullets might actually have a BC close to the 168 Sierra or 168 JLK. The results, which were calculated using Ballistic v4.00 by W.R. Frenchu, (available as shareware on the NRA bulletin board) were a real eye opener! (See table 1)

The 168 7mm Wall Bullet showed a calculated BC of 0.666 corrected to standard temperature and pressure (STP) from the existing conditions. (98 degrees, 29.98 and falling barometer, 58% relative humidity) That's not so great you say? Well the calculated BC's for the Sierra 168 7mm and the JLK 168 7mm were 0.545 and 0.615 respectively when corrected to STP!

Now before any of you out there die of shock, or have a hissy fit, be aware that I know these numbers are not as high as you have seen published by the other bullet manufacturers. After calculating these figures several times with the same results each time, I decided to try entering the velocity differences found in the Sierra reloading manual. This would show what the calculated BC would be, if the Sierra 168 7mm matchking corresponds to a BC of approximately 0.620, what they claim it to be! The only problem is that the Sierra 168's we tested didn't come close to the velocity drop figures in the reloading manual. (see table 2) For that matter the 168 JLK 7mm did not live up to its published BC either. It has been published in the Champion's Choice catalog as being 0.690 and we measured it at 0.615. This would mean that Ron's 168 7mm is approximately 18% better than the Sierra 168 7mm and approximately 7.5% better than the JLK Low Drag 7mm 168.

One thought occurred to us after getting these results. Maybe the three chronographs were not in sync and that was the reason for the lower than expected results. So we placed all three

TABLE 1
Velocity Drop and Calculated BCs

BULLET TYPE	WEIGHT GRAINS	STARTING VELOCITY (FPS)	100 YD VELOCITY (FPS)	300 YD VELOCITY (FPS)	MEASURED BC (G1)*	BC AT STP (G1)*
SIERRA	168	2579	---	2148.5	0.575	0.545
JLK LD	168	2610.5	---	2226.3	0.656	0.619
WALL LD	155	2646.7	2386	2247.1	0.634	0.599
WALL LD	168	2644.9	---	2284.7	0.710	0.666
WALL LD	185	2654	---	2314	0.756	0.715

*G1 Drag function table used in Ballistic v4.00 by W.R. Frenchu for all calculations

TABLE 2
Published BCs Verses Measured BCs

BULLET TYPE	MUZZLE VELOCITY (FPS AVG)	300 YD VELOCITY (FPS AVG)	PUBLISHED BC	MEASURED BC
SIERRA 168 (pub. data)	2600*	2187*	0.620*	---
SIERRA 168 (actual data)	2579	2100	---	0.545
JLK 168 LD (pub. data)	2600**	2234**	0.690**	---
JLK 168 LD (actual data)	2610	2226.3	---	0.619
JLK 180 LD (pub. data)	2600**	2255**	0.734**	---

*Taken from the Sierra Manual Second Edition

**Velocities from Ballistic v4.00 to give a BC of 0.690 or 0.734 at STP, when calculated under the same conditions as when testing took place, Published BCs from Champion's Choice Catalog 1993-1994

TABLE 3
Velocity variations between chronographs

CHRONOGRAPH	SHOT 1	SHOT 2	SHOT 3	AVERAGE
OHLEH 33 (RON'S)	2557	2557	2528	2547.3
PACT PC (MINE)	2554	2576	2582	2570.7
PACT PROFESSIONAL (DON'S)	2517	2511	2538	2522

chronographs side by side and shot several rounds over them to compare the velocities. (after putting new batteries in Ron's) We figured that this would show if the difference in velocity between the chronographs was the culprit. Interestingly enough, this proved futile, as the differences between the chronographs would have made the BC's lower than they already were. My chronograph which was at 300 yards read higher than

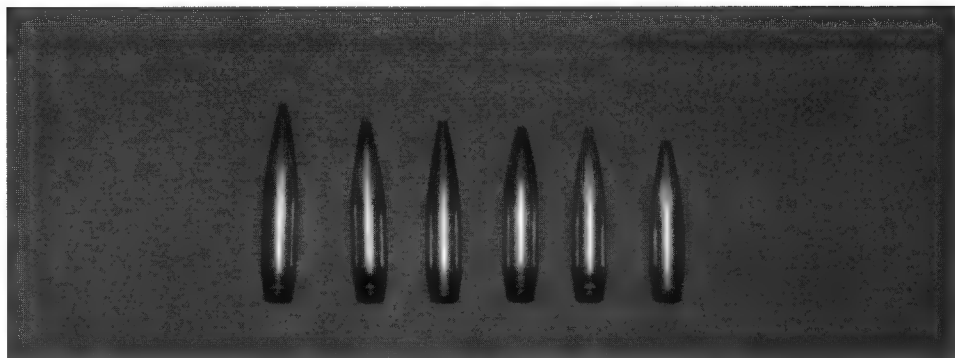
Don's, if it had been reading the same velocity as the others the velocity drop would have been greater. (see table 3)

Shortly after this experience I read an article by a well known writer for another shooting magazine. He performed an exhaustive study of all the 30 caliber 165-168 grain bullets including Speer, Sierra, and Hornady 168 match bullets. His results, performed with an Ohler PBL (personal ballistics laboratory) showed

that the BC's of all three 168 match bullets were around 0.370 to 0.380. This is well below the published BCs for all three bullets. One could come to the conclusion that either the majority of chronographs available today are not worth the cardboard they are shipped in, or the BCs that we have accepted as gospel truth until now are sorely inflated. In fact if you look at the statistical variation around the average velocities in our data you can see that the actual variation could be great enough to account for the difference in calculated BCs. I haven't done the actual analysis on this data because the number of data points for variation between chronographs (3) is not enough to do a thorough statistical analysis of variability between the three chronographs.

I have done some sensitivity analysis around velocity effects on BC. This indicates that very small velocity changes can affect the BC of a bullet significantly. The end result is this: we can say that the BCs of the Wall 7mm bullet is higher than those of either the JLK low drag or Sierra 7mm bullets. As to the actual BC and percentage difference, we have not established it exactly, only given an indication of the magnitude of the change.

In summary, let me say that the Wall 168 Low Drag bullet has a BC of 0.666 at STP relative to the 168 JLK @ 0.619, the 155 Wall Low Drag @ 0.599, and the Sierra 168 @ 0.545 **when fired under the same conditions with this equipment.** The actual BCs may vary significantly under other conditions with other equipment. Although this is not definite proof that the BCs of the Wall bullets is higher by 7.5 percent than the JLK or 18% higher than the Sierra, it does indicate strongly that the BC is **better!** As for me I will



Left to right: 185 Wall LD, 168 Wall LD, 168 JLK LD, 168 Sierra, 155 Wall LD, 140 Wall LD.

be shooting the Wall Low Drag bullets in competition and will report back on the results in a future issue.

I did not include the BCs of the 140 Wall Low Drag because the group I fired at 300 yards was below the chronograph due to mental mistake (I cranked the sight 3 minutes down to move the group 3 inches... still thinking 100 yards here!) and none of the shots were recorded. We also tested the 185 Wall bullet and the tests produced a BC of 0.715 at STP for the 185 Wall Low Drag bullet, however we did not test the 180 JLK.

You can contact Ron Wall of Home on the Range Competition at:

Home on the Range Competition
Rt. 2 Box 431
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(918) 543-3081

Good shooting, and may all your nines be close!

Theron D. King
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P.S.

The first 600 yard match I fired with the

155 Wall Low Drag bullets was a 197-14x with an 8 on the first shot. The 8 was on call. (sometimes I pull the trigger at the stupidest times!) At Camp Perry I won the last offhand match (198-4x) and placed second in the Standing Slow Fire Aggregate (582-7x to Mitch Maxberry's 582-16x) using the 140 Wall Low Drags. I also shot another 197-14x at 600 yards using the 155 Wall Low Drag bullet. (three nines, all on call!) Damn gun and bullets shoot right where I point 'em! TDK.



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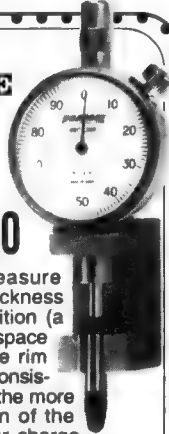
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This is a gage to measure consistency of rim thickness on .22 rimfire ammunition (a .22 rimfire rifle's headspace is determined by case rim thickness). The more consistent the rim thickness, the more consistent the ignition of the primer and the powder charge in the case. In other words, the firing pin will fall the same distance every time if the same rim thickness is used on every case being fired for a particular group. By sorting the shells into various groups by rim thickness, a reduction in group size of up to 25% can be realized in some IF NOT MOST rimfire rifles. This information about group reduction comes from the .22 rimfire benchrest participants who compete in the extremely difficult BR-50 matches. All of the top shooters sort their shells into groups by checking rims and weighing the unfired cartridges.

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HOME-MADE "PRESS CASE EJECTOR"

(Walter Engel)

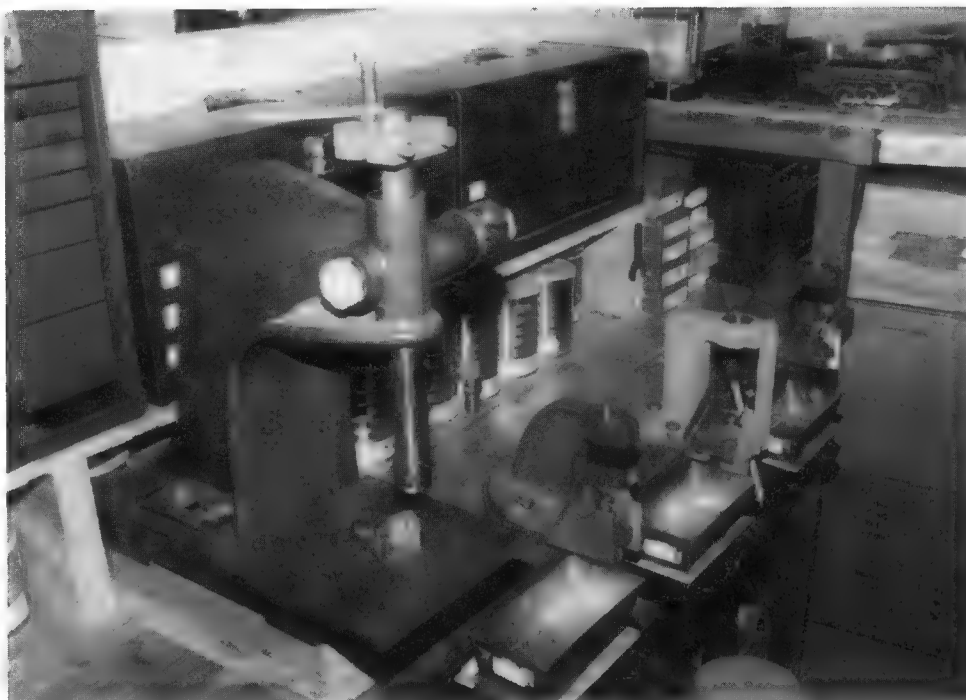


Photo #1

Dear Dave:

Enclosed is a brief article and a few pictures of a press case ejector I have made.

For a long time I have looked longingly at all the progressive loading presses on the market. But I know, deep down, that I don't really need one. My loading bench has several old fashioned single stage presses, picture #1, two old Super Pacifics I have used since 1946, a Lyman Orange Crusher, two Potter Gems, and the best, a #2 Greenard Arbor Press. Each of these have some particular use in reloading cartridges. The Pacifics are used for sizing pistol and the Lyman for sizing longer rifle cases. The Potters for decapping and neck expanding, while the Arbor Press is used for straight line die bullet seating. I prime all cases on a small press I made many years ago.

As you all know to resize a case with a single stage press you must place it in the shellholder, come up with the ram, then down, then take the case out of the shellholder. Rather time consuming compared to the rapid functioning of the progressive case. I wished I had some sort

of device that would remove the case from the shellholder on the downstroke of the ram. This would cut the work in half since all I would have to do is insert the case and not have to remove it. Well after giving the problem some thought I came up with the solution. Actually the part just seemed to come together and it really is very simple and not that difficult to make.

I did not wish to have to alter the presses in any way. So the slot in the frame where the priming arm is located was selected as the installation point. Picture #2 shows the device mounted on the Super Pacific. As can be seen it resembles the letter Y laying on its side. It pivots at a point where the three legs of the Y intersect. The lower left leg has a 4-40 screw that fits and slides in the ram slot. When the ram is brought down the screw finally touches the bottom of the shellholder in the ram, picture #3. As the ram moves down the Y pivots down and the longer screw in the upper leg of the Y contacts the cartridge case and pushes it out of the shellholder, picture #4. Now in order to put another cartridge case in you

must raise the ram a little. This will allow the counterweight which are the washers attached to the long right leg of the Y to rotate the device. This motion gets the longer screw out of the way of the shellholder, picture #5. This presents the only problem with the device, since the ram has been raised about 1/2" a long case may not clear the die bottom when trying to place it in the shellholder. A long throated press like the Lyman Orange Crusher does not present a problem and that's why I use the Lyman for longer cases and the shorter Pacifics for pistol length cases. Of course you must make some arrangement to catch the ejected cases and I have made a little trough to catch them. These were made of cardboard until I finally reached the desired shape. Then using the cardboard as a template I made some out of thin brass sheet as can be seen in the pictures. If the device presents any problem for a very long case it can easily be removed and normal press usage occurs. Also the same is true if you want to use the press for priming by removing the device and installing the regular priming arm.



Photo #2

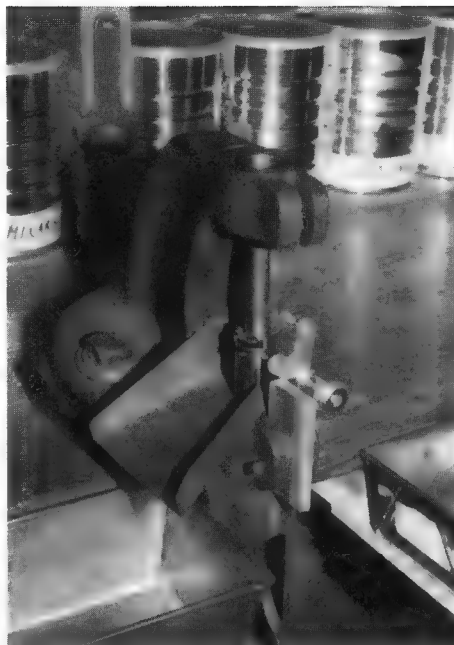


Photo #3



Photo #4

The actual construction is as follows, there are really only three parts and I made them out of aluminum because I had some. I suppose even plastic might do but I have not tried it. The base is a block of 1/4" by 1" by 2 1/4" aluminum bar. I had to add a little plate of 1/16" by 3/4" by 1" aluminum plate to get the pivot point where it had to be to clear the ram. This plate was secured to the base by two 2-56 screws. The Y was cut out of a small piece of 1/16" aluminum sheet. I drilled the holes and cut it to shape with a hacksaw and then finish filed it. Picture #6 shows the device and how the small plate is attached to the aluminum base. The counterweight is simply a few washers having enough weight to give a nice rotation to the Y plate. I have made at least a dozen of these for friends and they seem to fit all the various presses. When the device is completed you can drill a 1/4" hole through the aluminum base and use the original primer arm pivot pin to hold it in place on the press.

I realize that this project may be a little too difficult for some. But to me half the fun of being a gun nut is making the things that I want, and can not find or afford to buy.

Walter Engel
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Photo #5



Photo #6

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More on Heat Treating Cast Bullets

by
Glenn R. Latham

Scanning through the table of contents of the January '95 Precision Shooting, my eyes were drawn to the article titled, "Heat Treating Cast LED Bullets." Wow, I thought, 90s technology has brought us the light emitting diode cast bullet. However, upon flipping back to page 60, my bubble was burst. Maybe in the next century.

Roger Johnston's article was very good. It is quite true that for infinite stability of cast bullet hardness, the final heat treated hardness should be the same as the hardness the alloy will reach upon air cooling and aging. I have found, though, as a practical matter, cast bullets heat treated far above their air-cooled hardness will retain that hardness long enough to be quite useful. Only when you are "pushing the envelope" will a slightly softened bullet cause trouble. Also, there are applications where a high antimony bullet is a poor choice, but one of the same hardness cast of an alloy containing less antimony will perform admirably. More on this later.

Digging through the boxes of various cast bullets on the shelf in my shop, I ran across a box of .38 cal. SWCs that had been cast of wheel weights and heat treated to a hardness of 29 BHN in April of 1993. I tested them again (January 1995), and found they had softened to 19

BHN. Yes, that is quite a bit, but they were still nearly as hard as fresh linotype (nominally 22 BHN), and as hard as typical "used" linotype which bullet casters often buy. They are still hard enough to handle any load a .357 Magnum or Maximum can dish out, and most .35 rifle loads as well.

This hardness loss agrees with what Dennis Marshall of the NRA Technical Staff experienced and reported in his excellent article "Stronger Bullets with Less Alloying", printed in the NRA book "Cast Bullets".

When I was hunting with my old M-70 chambered in .30-06, I had worked up to a maximum load of 58 grs. of IMR-4350 with the LBT .310-140-SP (147 grs.). This load generates 2850 fps and shoots groups under 2" at 100 yards. I used it for hunting for a number of years, but I discovered that ammunition left over from the previous year wouldn't stay on the paper. Since the bullets were right at the limit of the velocity and pressure they could handle when freshly heat treated to 28-30 BHN, the amount of softening that occurred in 12 months was just enough to render the bullets incapable of accurate flight.

Did the too-soft bullets strip the rifling? Not likely. Stripping is a phenomenon often charged but rarely convicted. Cast

bullets in high velocity or high pressure loads usually fail because the alloy is not strong enough to withstand the pressure, and are distorted. Try bending a jacketed bullet, and then shooting it. If you could chamber it, it certainly wouldn't shoot well, and neither can a cast bullet, especially since the base of the bullet receives the most pressure, and that is its steering end.

Oval bullet holes in the target usually tell you one of two things when shooting cast bullets: Either the velocity is too low, and the bullets are unstable, or the pressure is too high for the bullet hardness, and the base of the bullet is being deformed, causing it to tip in flight. This is of course assuming the bullets were good to begin with! Shooting undersized bullets, especially in a revolver, will generate oval bullet holes.

What about loads that require a bullet of exactly a certain hardness for accurate shooting? For such an application it would probably be advantageous to use an alloy that will not change hardness over time, unless the hardness requirement is too high. If the required hardness is over about 22 BHN, it will be difficult to find an alloy that will maintain hardness over time.

Another consideration if such a hard alloy is needed is the resultant weight of the bullet. A .30 caliber cast bullet that weighs 190 grains when cast of wheel weights (nominally 12 BHN) will weigh less than 180 grains when cast of lino-

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type (22 BHN). This weight change will of course affect the sectional density and ballistic coefficient of the bullet as well. The difference isn't great, but it will result in slightly greater wind drift.

Possibly more important than a difference in ballistic coefficient is the difference in stability. This also isn't astronomical, but I have experienced stability problems when changing alloys. A less dense bullet alloy will require a faster twist, just as a more medium (i.e. cold or humid air) will require a faster twist to stabilize a given bullet, as many benchresters have discovered when shooting boattail bullets in the winter. Since it is fashionable to use the least amount of twist necessary to stabilize a bullet, playing with alloys could lead to stability problems.

But for most cast bullet applications, small changes in hardness are not critical, as long as the bullet is hard enough. Quenching bullets directly from the mould will result in varying bullet hardness, but the bullets will be found to be entirely satisfactory for high power or hunting practice with somewhat reduced loads, and 99% of pistol applications. Even for the demanding sport of handgun silhouette, I found direct quenched bullets to be entirely satisfactory.

One trick I tried recently which worked very well will generate slightly harder direct quenched bullets and speed up the casting cycle. I placed a small sponge in a shallow lid on the workbench and soaked it thoroughly with water. In order for bullets quenched directly from the mould to attain a significant hardness increase, the bullets must be very hot. Thus it is necessary to use a fairly brisk casting rhythm and heat the mould until the bullets emerge frosted all over, but perfectly filled out. At the minimum proper mould temperature the bullets will emerge perfectly filled out and shiny, when casting with a low antimony alloy such as wheel weights or wheel weights diluted with lead. As the casting cycle is increased and the mould becomes hot-

ter, the bullets will begin to show patches of frosting, which generally are not completely filled out. If the pace is continued, the mould will become hot enough that the bullets will be evenly frosted all over and perfectly filled out as well.

At this mould temperature the sprues will take quite a while to solidify, and longer yet before the alloy has cooled sufficiently that the sprues can be cut without tearing metal from the base of the bullet or smearing soft alloy over the tops of the mould blocks and the bottom of the sprue plate — a very messy situation. As soon as the sprues have solidified (gone from shiny to frosty), touch them to the wet sponge for one second, and then immediately cut the sprues and dump the bullets into a bucket of water. Caution: Place the bucket of water behind you, so that you are blocking any splashes from reaching the lead pot! If the bottom of the sprue plate and the top of the mould blocks are thoroughly scribbled over with a common lead pencil before casting begins (or better yet painted with NEI Mold Prep), lead smears will be avoided.

While it is true that sizing heat treated bullets will cause a softening of the sized surface, this softening is confined to a layer .001" to .002" deep. I have experimented with bullets sized both before and after heat treatment, and the only time I found a difference was when I was pushing little .22 caliber cast bullets to 2900-3000 fps in my heavy Shilen barreled .223. These bullets weren't simply sized, but actually bumped in an enclosed die, so the amount of metal movement was greater than simple sizing. One thing to keep in mind though, is that hard bullets will emerge from a given sizing die large in diameter than the same bullet if sized soft, as they have greater springback.

When hunting with high velocity cast bullets, it is necessary to use an alloy with as little antimony as possible, or not more than about three percent. Bullets

with too much antimony are brittle and too violent for big game hunting.

Bullet hardness is the deciding factor determining the minimum velocity required to expand a cast bullet, not alloy content. A linotype bullet of 22 BHN will expand at the same velocity as a bullet cast of wheel weights and heat treated to 22 BHN, but the linotype bullet will expand much quicker, causing a large wound near the surface and leaving less of the bullet intact for deep penetration. The wheel weight bullet will show a more consistent wound channel and will have a higher retained weight for much deeper penetration, usually 100% on deer sized game.

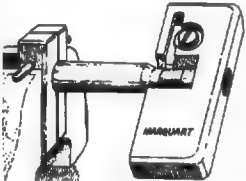
If an intermediate hardness is required, such as 18 BHN, the bullets can be heat treated to full hardness and drawn back to the desired hardness. This will require some trial and error, but for starters place the fully hardened bullets in the oven at 250 degrees for an hour, remove them and either air cool or water quench them. Since the temperature is far below what is required for the antimony to dissolve into solution with the lead, quenching will not harden the bullets. Hardness can be measured as soon as the bullets reach room temperature.

So if the cast bullet application isn't sensitive to exact bullet hardness, give yourself a break and quench your bullets from the mould. If it is hardness sensitive, carefully heat treat (and draw if necessary) and only lubricate as many bullets as you expect to use, and note the date and keep it with them.

Although there is plenty of enjoyment found in meticulous casting, handloading and shooting, I also like to remember the words of Skeeter Braswell, as reported by Frank D. Randall: "If shooting isn't fun, what's the use."



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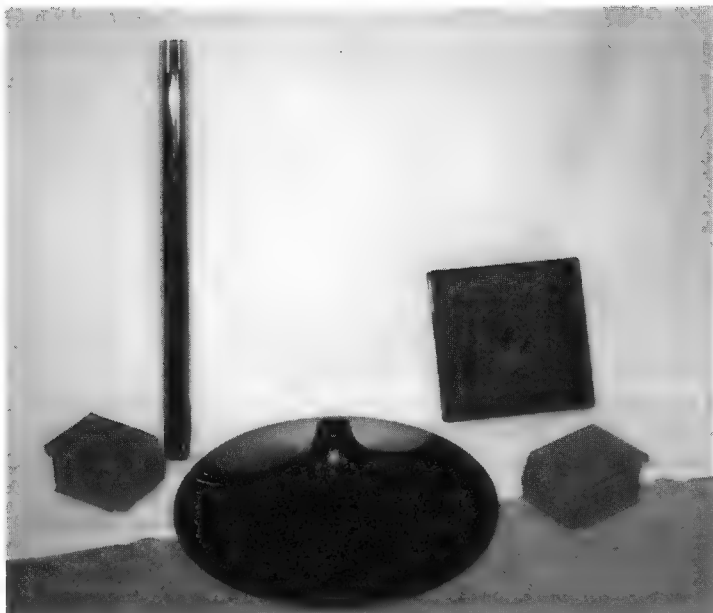
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1. The reloading stand consists of the round floor plate, chromed central post, square work top and two parts bins.



2. Assembly requires only a few seconds. The parts bins hook on the sides of the top and the top will rotate.

THE MIDWAY REVOLVING RELOADING STAND

by
Bob Jourdan

The necessity to use extra time at the shooting bench to clean a stubborn barrel had cut my time for reloading my match cartridges severely. By the time I got to the open-air loading tables under the oak trees at the Luther, Oklahoma benchrest range all the other shooters were finishing their reloading. The call to the shooting line was only minutes away. Could I get my eight cases reconditioned and loaded quick enough to prevent asking the rangemaster for a delay...or even perhaps being disqualified for not reporting to the line in time for the next match?

It would be close, but I knew I had an ace in the hole in the way my reloading equipment was set up. I was using the new, portable revolving Midway Reloading Stand from Midway, 5875-D W. Van Horn Tavern Rd., Columbia, MO 65203. This stand came on the market in early 1995 and consists of a large, 18" round base with a center hole for placing

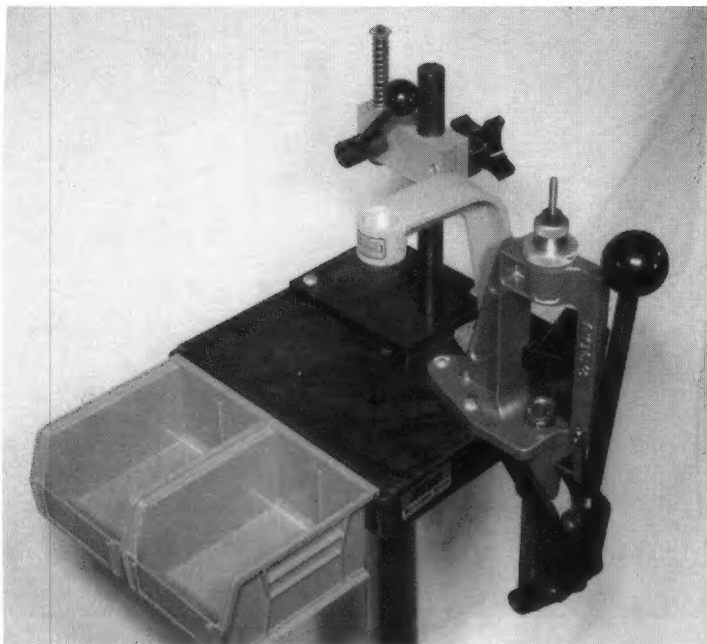
the chromed steel center post. A 9"x9" top slips onto the post and there are a couple of nice accessory bins that can be positioned anywhere along the edges of the top. Extra tops and bins are available and I have added a third bin to my top. This allows me to keep all my necessary accessories handy, such as my primer pocket uniformer, Sinclair comparator, Lee Auto Prime tool and primers, plus bullets and bullet seater. Occasionally I keep a one pound canister of powder in one bin, but this really means that I should add another bin for a total of four. Other tools kept in these bins from time to time include hex wrenches, a small screw driver, a second size of Wilson case neck bushing, a case neck brush, etc.

The top is an exceptionally sturdy reinforced plastic or nylon material that comes with a template for drilling holes suitable for mounting most any loading

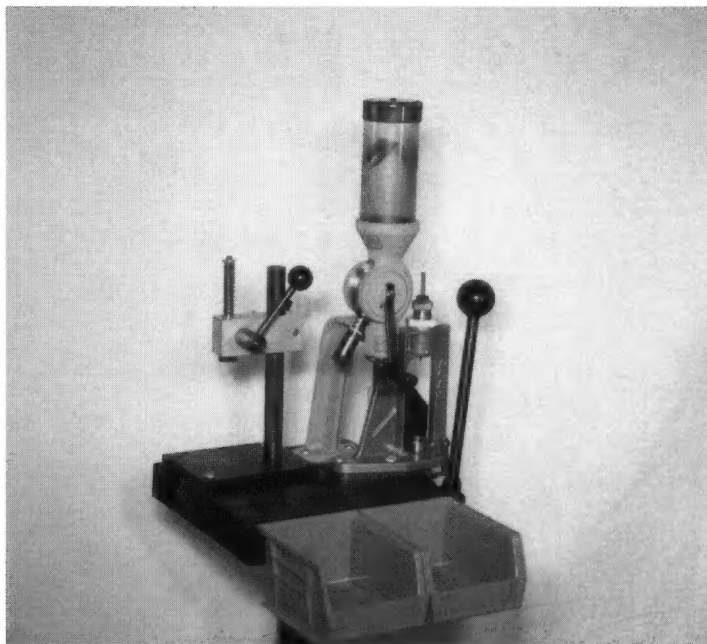
press or other tools. This template is really not necessary since you will probably C-clamp your various tools to the top for trial positioning then simply mark through the holes for drilling. The one thing to watch for is the reinforcing webs under the table top that you sure don't want to drill into. Just be sure to check under any hole location before you drill.

Midway shows the reloading stand with only a loading press attached, but I see no reason to limit the stand to only one tool. Therefore, by trial and error, I was able to fit my RCBS Partner press, Redding BR30 powder measure stand and Sinclair arbor press to the top and still have room to do the jobs. By using wing nuts on all bolts, tools are not necessary for removing any of the equipment, if you should need to do so.

Benchrest shooters, in recent years, have begun using the little RCBS Partner press and special 7/8x14 screw-in dies



3. This arrangement has the two bins together on one side of the top. The three loading tools used in this example are bolted to the top and wing nutted for quick removal. The tools are a Sinclair arbor press, a Redding powder measure stand and the RCBS Partner press.



4. The reloading stand ready to use after installing the Redding BR30 powder measure in the measure stand. The Sinclair arbor press required drilling a pair of mounting holes in the arbor base, but the other tools both have factory drilled holes.

that are designed to use Wilson neck sizing bushings of any size. My particular die was made by Clarence Hammonds of Hammonds Rifles, 415 Greenway, Red Lion, PA 17356, an advertiser in PS. This die does several jobs with just one stroke of the press handle. It decaps, neck sizes through the removable Wilson bushing, and can be adjusted to bump back the cartridge case shoulder just enough to always assure easy bolt closing – even when shot over and over with excessively hot loads. This has speeded up benchrest reloading considerably.

When fitting out my Midway Reloading Stand top, I found that by installing the tall, upright Redding powder measure stand for the BR30 measure, a lot of table top surface was left useable for other things. Work could be done under the tall clearance of the measure and stand. For example, a Sinclair cartridge loading block will rest nicely on the top under the measure. When disassembling the stand for travel, the BR30 measure is removed from the stand and all other equipment remains bolted in place. It would be easy enough, however, to loosen the wing nuts and remove any other equipment if desired.

The reloading stand top is easily rotated on the center post. The user can sit facing the stand and turn the top to move the proper tool in front of him for use. When a fired case is ready to work over, the RCBS press is turned to the front and

the case is decapped and sized. Then by use of the primer pocket uniformer and Lee primer tool from one of the reloading stand bins, the case is ready for powder. The BR30 measure is rotated into position and the case is charged. Then by a final rotation of the top the Sinclair arbor press is positioned for bullet seating. The Wilson bullet seater and bullets are kept in one bin waiting for this last step that only takes seconds. The cartridge is

finished at this point. Of course, these steps are done in sequence for all cases, and on the day of the Luther shoot when time was running out on me, I ran the eight cases through the RCBS press, then all were primed and charged, and finally all had bullets seated in them and I was ready to go. By having all the equipment concentrated on the revolving stand the time required for this reloading

Continued on next page

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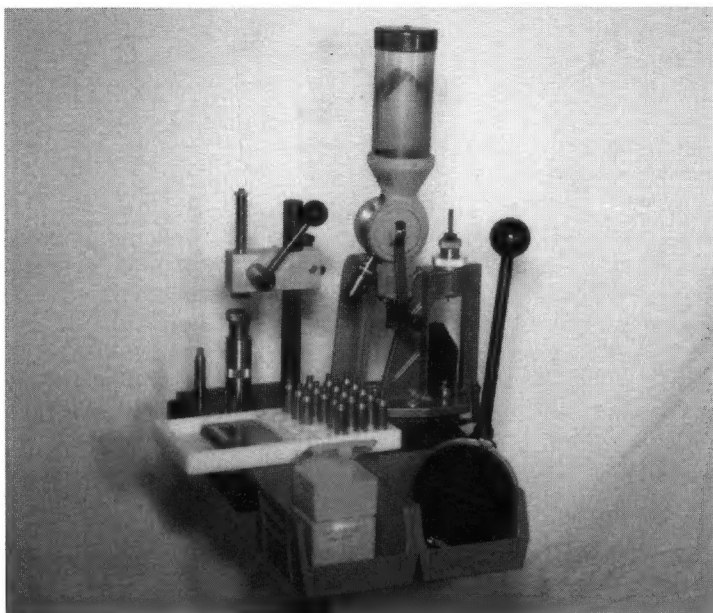
If you want a better shot at a Hummer, set your sights on a Shilen.



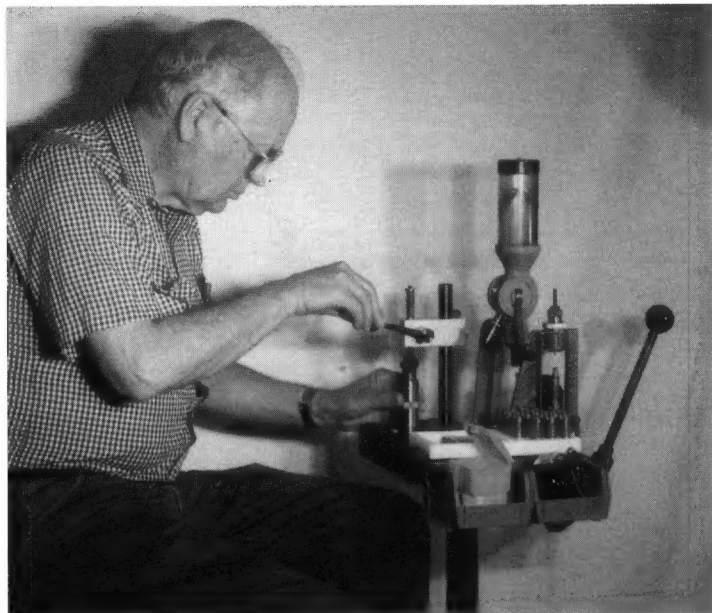
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5. The compact Midway Reloading Stand will hold all necessary items including a Sinclair cartridge case tray, Wilson bullet seater, Lee priming tool and bullets, plus other small items held in the bins.



6. In use, seating bullets. By rotating the top the RCBS Partner press would be directly in front of the operator when needed. An exceedingly handy set-up.

THE MIDWAY REVOLVING RELOADING STAND

Continued

was probably reduced at least 25%. I finished just as the rangemaster called shooters to the line....

Originally, I was quite concerned about the possible quality of any rotating, portable loading table, being made of a form of plastic and being lightweight. Curiosity got the best of me and I ordered one out. At first I set it up and showed it to my shooting friends...who were just as skeptical about plastics as I. They looked...smiled knowingly...and went away. But when they next saw it, it

was all set up and in use at our local range. They were then highly impressed with the quality and especially at just how handy it made reloading at the range while sitting at the shooting bench. They could hardly believe it when I simply picked the top, with equipment attached, right off the central post, removed the post from the base plate and placed the three parts in the vehicle and drove away....

I have now used this reloading stand in my shop at home, in my fifth wheel RV at

various rifle shoots, at ranges with concrete pads...and of course right out on the dirt under the trees at the Luther shoot. And every time I use it I remember back to my early days when my very first reloading tools were moved from the kitchen table to an 18"x18" so-called portable reloading table made from 2x4s, nailed together under a plywood top. I had to hold it steady by keeping my foot on a cross-member, and of course I could not get all the tools mounted on it and still had to resort to the kitchen table for some of the work. That bad little table held out for a year or so, until I finally found room to build a real workbench along a wall in a garage. That will soon be a half-century ago.... How time does fly!

The photos show how the little table works, and how the reloading tools were placed so as to be easy to use. Different tools will have to be placed differently, and I believe the very large bench presses would not be good choices on this stand. Most tools can be arranged to work out if you use the old standby, trial and error method of fitting them on the top. At a price of around \$40.00, this Midway Reloading Stand can be highly recommended.

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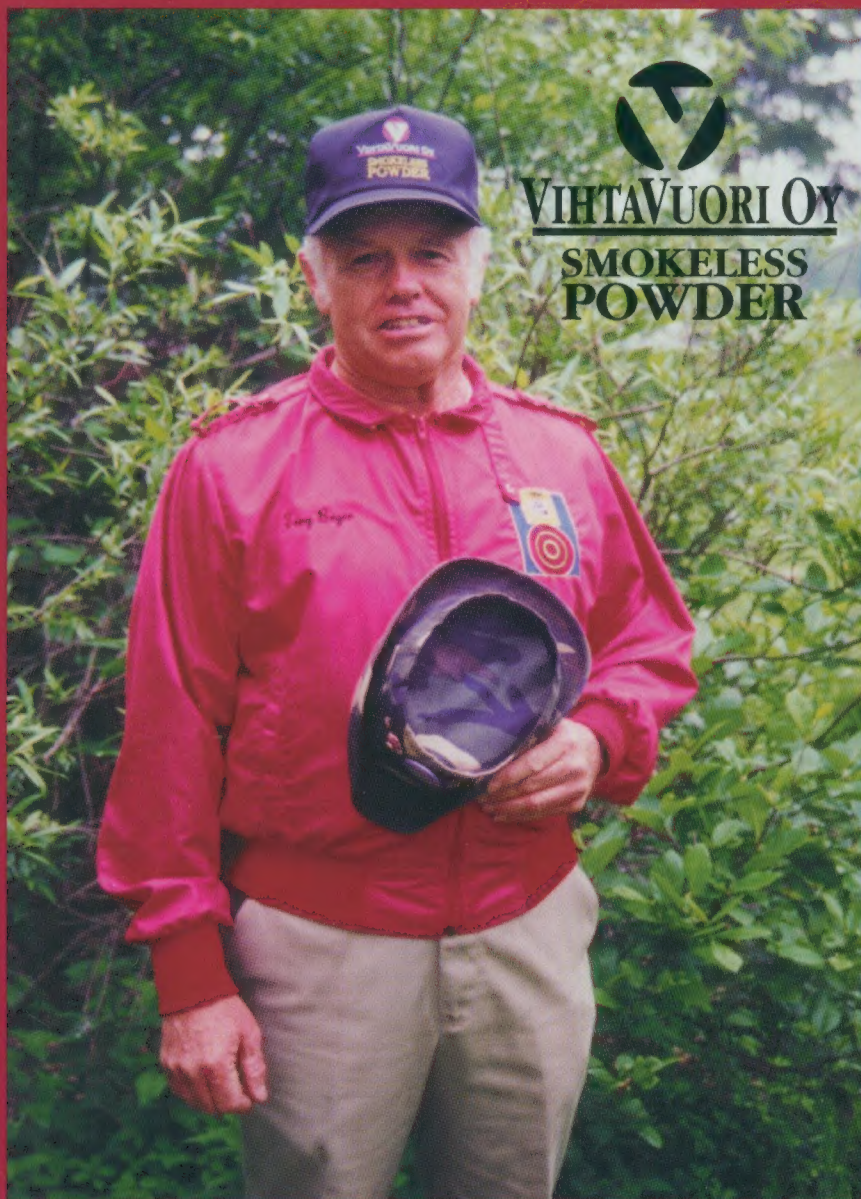
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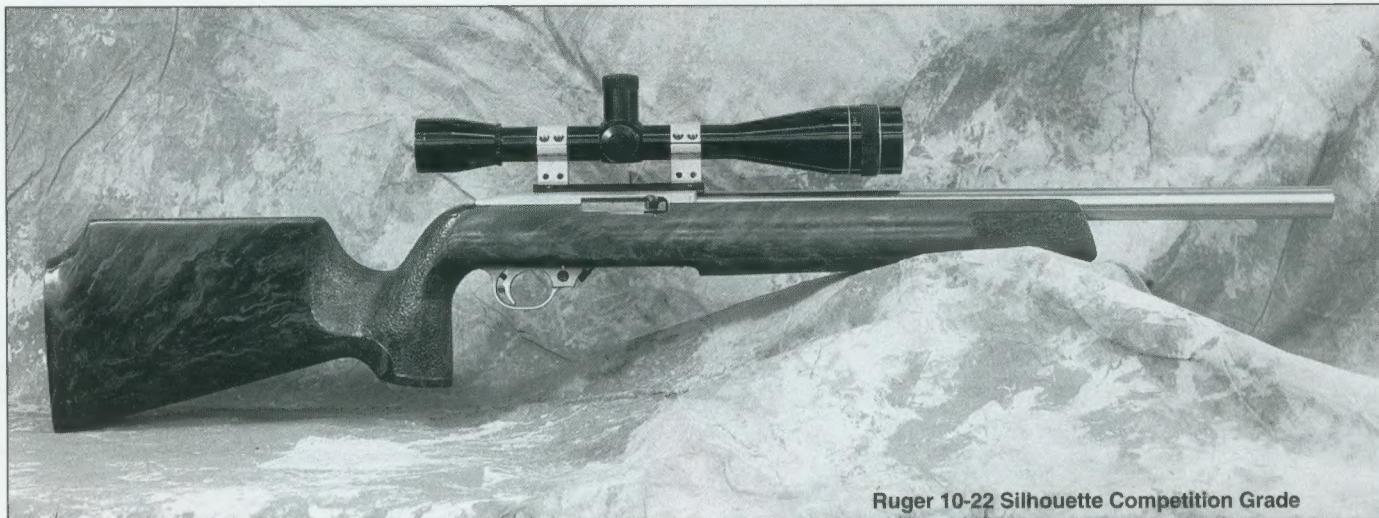
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Williams Precision, Inc.

Office: 2076 West Park Place • Stone Mountain, Georgia 30087
Shop: 1300 Grayson Parkway • Grayson, Georgia 30221
404-985-1332

*To meet our criteria, the Super Match Grade rifle must shoot 3 out of 5 - five shot groups less than .250" agg.

**Scopes not included.

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